PLANT PATHOLOGY

A RECORD OF CURRENT WORK ON PLANT DISEASES AND PESTS

Published Quarterly for the
Ministry of Agriculture and Fisheries
Plant Pathology Laboratory
Harpenden, Herts

VOLUME I, No. 3

September, 1952

LONDON: HER MAJESTY'S STATIONERY OFFICE

York House, Kingsway, London, W.C.2; 423 Oxford Street, London, W.1
13A Castle Street, Edinburgh, 2; 39 King Street, Manchester, 2;
2 Edmund Street, Birmingham, 3; Tower Lane, Bristol, 1;
1 St. Andrew's Crescent, Cardiff; 80 Chichester Street,
Belfast

CONTENTS

	Page
Laemophloeus spp. as Major Pests of Stored Grain. *J. A. Freeman* ..	69
Chrysanthemum Flower Distortion Survey, 1951.	77
Hot-Water Treatment of Celery Seed in Lancashire. *J. H. Bant and I. F. Storey*	81
A New Bacterial Disease of Leeks. *R. A. Lelliott*	84
The Distribution and Prevalence of Potato Gangrene. *C. E. Foister* ..	85
Symphilid Damage to Tomatoes. *L. N. Staniland and L. E. W. Stone* ..	87
The Rapid Assessment of Apple Scab on Fruit. *H. E. Croxall, D. C. Gwynne and J. E. E. Jenkins*	89
The Identification of Aphids of Economic Importance. *H. L. G. Stroyan*	92
The Weather of England and Wales : Autumn and Winter, 1951–52 ..	101
New or Uncommon Plant Diseases in England and Wales.	101

Plant Pathology is sold direct by Her Majesty's Stationery Office at the addresses given on the title-page or through any bookseller. Price of single copies 4*s.* 0*d.* net (4*s.* 1½*d.* by post). Subscription-rate 16*s.* 6*d.* for four issues, including postage. Subscriptions, notifications of changes of subscribers' addresses and enquiries about delivery of copies should be addressed to H.M. Stationery Office, P.O. Box No. 569, London, S.E.1.

Unless otherwise stated, all material in this publication is Crown Copyright, and may not be reproduced without the permission of the Controller of H.M. Stationery Office.

The Ministry accepts no responsibility for the commercial advertisements included in this publication.

In the interests of factual reporting, occasional reference in this Journal to trade names and proprietary products may be inevitable. No endorsement of named products is intended, nor is any criticism implied of similar products which are not mentioned.

Manuscripts for consideration and all correspondence on plant pathology matters should be addressed to the Editor, *Plant Pathology*, Plant Pathology Laboratory, Milton Road, Harpenden, Herts. Other editorial correspondence should be addressed to The Production Editor, *Plant Pathology*, 3 Whitehall Place, London, S.W.1 (Tel. Trafalgar 7711).

PRINTED IN GREAT BRITAIN

LAEMOPHLOEUS SPP. AS MAJOR PESTS OF STORED GRAIN

by J. A. FREEMAN

Infestation Control Division, Hook Rise, Tolworth, Surrey

During the past ten years a number of outbreaks of *Laemophloeus* spp. as the principal or sole pest, have occurred in grain stored in the United Kingdom, principally in Manitoba wheat stored for long periods. These infestations have been mainly in grain held in large shallow bulks on floors, but some have occurred in silos. There have been none of consequence in bagged grain. The purpose of this article is to review these outbreaks, and to show that species of *Laemophloeus*, often classified as secondary pests incapable of attacking undamaged whole grain, may sometimes be the initial cause of grain heating in the United Kingdom, and that they are capable of causing such heating in grain of reasonably low moisture content.

Grain that heats is liable to cake, to become mouldy and musty, to sprout, and to suffer loss of germinative power and milling and baking quality. Anderson (1943) found that heated grain from the centre of "hot spots" (90–105° F., moisture content 10·8–11·8 per cent) showed a loss of baking strength, with from 4 to 25 per cent reduction in loaf volume.

Howe (1951), in discussing the identity of *Laemophloeus* spp. found in stored food premises in Britain, called attention to a species, since named *L. pusilloides* by Steel and Howe (1952), which was responsible for an infestation of bulk Manitoba wheat at Birkenhead in 1945 (Lucas and Oxley, 1946). The species most commonly found in infested grain in Britain, however, have been the Rust-Red Grain beetle, *L. ferrugineus* Steph. (Plate III, 2) and the Flat Grain beetle, *L. minutus* Ol. Reid (1942) gives a key for the identification of species of *Laemophloeus*. Plate III, 1 and 3, show typical caking of wheat following heating caused by the pests, and typical damage to grain, with burrowing in the germ area.

INFESTATIONS IN NORTH-EAST ENGLAND

Hull, 1941. The first outbreak discovered was during November 1941, in 130 tons of No. 1 Northern Manitoba wheat in bulk, stored in a warehouse at Hull. An endemic infestation of *Laemophloeus* probably existed in the fabric of the old brick warehouse on the top floor of which the wheat had been stored since July 1941. At a point against one wall the grain at about a foot below the surface was hard and damp, and had a temperature of 98° F., compared with 48° F. in other parts of the bulk. The damp portion had a strong aromatic smell and at the top there was a hard, dry part in which there were large numbers of *L. ferrugineus*. There was some evidence that rain water had leaked down a wall into the wheat and had thus provided conditions favourable for the increase of the pest.

Newark-on-Trent, 1944. In February 1944, at a store at Newark-on-Trent, heating was discovered in two places at the end of a bulk of 5,000 tons of Manitoba wheat. The wheat had been placed in store between September 1942, and May 1943, and was in a single bulk enclosed in bulkheads, 10 feet high, of bags filled with wheat. The maximum depth of the bulk grain was about 15 feet.

(54037) A*

The single-storied warehouse had brick walls and a concrete floor. The surface of the bulk in the heated area was caked, mouldy and sprouting in one or two places and the inner tiers of bulkhead bags were mouldy and rotten. The temperature of the main part of the bulk was 45° F. and in the heated part varied from 72 to 100° F. *Laemophloeus* sp. was the most numerous insect present ; others included *Oryzaephilus surinamensis* L., *Rhyzopertha dominica* F., *Calandra granaria* L., *Tribolium castaneum* Herbst., psocids, and *Lariophagus distinguendus* Först. After removal of the heating wheat, a crust of rotten wheat 2 inches deep remained on the floor. The infestation probably originated by invasion of insects from an adjacent maltings.

Immingham, 1948. In 1948 a large concrete silo at Immingham, Lincs, was thoroughly cleaned, and all bins which had held infested imported grain were sprayed with a heavy oil spray containing 1·3 per cent pyrethrins. Subsequently all the bins were treated with BHC smoke generators. In September 1948 English wheat was received direct from two National Grain Silos, where it had been dried, in barges which had been sprayed before loading. During 1949 a few outbreaks of insects occurred, principally *O. surinamensis*. *Laemophloeus* was not found, although it had been present in 1948, before the silo was prepared for the reception of English wheat. When the silo was empty, in August 1949, all the bins were treated with BHC smoke generators. The silo was then filled with new crop English wheat (moisture content 14–15 per cent*) from the same drying plants, and the same precautions were taken as in 1948. Outbreaks of *O. surinamensis* occurred during the autumn and the complete stock of wheat was fumigated with " Cyanogas G " (calcium cyanide) during January 1950 at a dosage of ½ lb. per ton. During the summer of 1950 outbreaks of *Laemophloeus* occurred in eight bins ; temperatures rose to 105° F. and caking of grain took place. These bins were treated successfully with carbon tetrachloride at a rate of 12 gallons per 100 tons of wheat. A careful study of the history of this case showed that the outbreaks of *Laemophloeus* sp. occurred only in those bins which had not been sprayed in 1948. The *Laemophloeus* sp. had apparently been able to survive two treatments with BHC smoke and one with " Cyanogas " before causing infestations in 1950. It is possible but most unlikely that the insects were introduced with the wheat.

INFESTATIONS IN SOUTH-EAST AND EAST ENGLAND

London, 1943. In December 1943 heating was discovered in one part of a bulk of 500 tons of Manitoba wheat stored from July on the fourth floor of a multi-floored bulk storage warehouse in London. The maximum temperature was 100° F. in the centre of the hot spot ; 60° F. six feet away ; and 44° F. in the main bulk of the grain, which was not infested. Air temperatures at the time were about 45° F. The grain near the hot spot was caking and going mouldy. Four weeks later the maximum temperature was over 110° F. and there was more extensive growth of moulds. The moisture content of the grain above the centre of the hot spot was 22–25 per cent. The only insects present in any numbers were *L. ferrugineus* and *L. minutus* in the proportion of 30 : 1. Other insects present in small numbers were *Palorus ratzeburgi* Wissm. and *C. granaria*, although large numbers of dead *Calandra* larvae were found in the grain from the centre of the hot spot. The initial heating may have been due to *C. granaria*,

* Moisture content determinations in the Infestation Control Division are carried out on ground samples dried in an electric oven for four hours at 105° C.

which was then overtaken and killed by the rapid rise in temperature produced by the *Laemophloeus*, which breed more quickly and can tolerate higher temperatures. The insects in this outbreak most probably came from the endemic population of the warehouse, and their development may have been assisted by local increase of moisture due to rain driving in through a broken window. Moulds present (identified by H. A. Dade of the Commonwealth Mycological Institute) were originally *Aspergillus chevalieri* (Mang.) Thom & Church, and *A. amstelodami* (Mang.) Thom & Church. These were later replaced by *Aspergillus candidus* Link ex Fr. and *Penicillium* sp. which require higher moisture contents.

London, 1951. In mid-December 1951 an outbreak of *Laemophloeus* spp. (principally *L. ferrugineus* with some *L. minutus*) was discovered in 300 tons of Canadian Amber Durum wheat stored in bulk in a floor storage warehouse in London. *C. granaria* and *O. surinamensis* were also present, but the *Laemophloeus* spp. were dominant. A series of temperatures taken in the bulk, which was caking at the hottest part, showed maximum temperatures of 88° F. and minimum ones of 57° F. Carbon dioxide production figures (Howe and Oxley, 1952) were 0·7 per cent where the grain was cool (moisture content 15·5 per cent) and 9·4 per cent where it was hot (moisture content 17·5 per cent). Since the warehouse is a general store housing all kinds of grain and other produce, the insects probably came from its endemic population. It is of interest that other parts of the same cargo, stored in this warehouse in bags, were not infested.

King's Lynn, 1952. The most recent outbreak, in February 1952, of *L. ferrugineus* and *O. surinamensis*, together with large numbers of *Lepinotus reticulatus* End. (Psoc. Trogiidae)—identified by E. Broadhead and B. M. Hobby—occurred in 3,500 tons of No. 4 Manitoba wheat stored since July and August 1951, in a single-storied, brick-walled, concrete-floored warehouse at King's Lynn. The wheat, which had a moisture content of about 14 per cent, was in a single bulk surrounded by bulkheads of filled bags and had a maximum depth of some 20 feet. The grain was heating in the centre of the bulk where it was caked to a depth of 6 feet. The infestation was first noticed because of a patch of sprouting grain, and here the loose surface was heavily infested. The maximum temperature was about 108° F. The infestation was controlled by fumigation of the bulk by a surface application of a mixture of carbon tetrachloride and ethylene dichloride at the rate of 1 gallon to 7 tons of grain. The grain continued to heat, however, indicating that insect heating had changed over to damp grain heating, the moisture content in the region of the hot spot being from 16 to 22 per cent. From the history of the warehouse it is probable that the insects were introduced with the grain.

INFESTATIONS IN SOUTH-WEST ENGLAND

Sharpness, 1940–50. A series of outbreaks has occurred in floor storage warehouses at Sharpness, Glos, where the construction of the stores, which have double walls, is such that when they are empty the control of the endemic populations is difficult. These stores contain grain in single bulks retained by the warehouse walls, the grain being about 20 feet deep. The walls are of brick or wood, the floors of concrete. The origin of all the infestations has almost certainly been the endemic population of the stores.

In a wooden-walled store an infestation of *L. ferrugineus* with severe heating was found, in March 1943, in 1,400 tons of Manitoba wheat stored there in

March 1942, after having been kept in another store since April 1940. A few *Laemophloeus* were found in May 1941. A new consignment of Manitoba wheat was put into store in late June and by the middle of February of the following year (1944) the whole bulk was heating up to 113° F., the surface being caked and mouldy. The dominant species was *L. ferrugineus*; others present were *O. surinamensis*, *R. dominica*, *C. granaria* and psocids.

In a brick-walled store in the same port an outbreak of *L. ferrugineus* accompanied by *Palorus ratzeburgi* Wissm. and *C. granaria* occurred in Rumanian wheat in May 1940 after it had been in store for a little over 12 months. The maximum temperature recorded in the hot and caked spot was 105° F., and in the cool part 55° F. In July 1943, 3,000 tons of Manitoba wheat was placed in store, and in April 1944 a hot spot was discovered near an elevator casing. The insect present in the largest numbers was *Laemophloeus* sp. together with a few *O. surinamensis* and *C. granaria*. On removal of the wheat around the elevator other insects were found, including *Latheticus oryzae* Waterh., *R. dominica* and *T. castaneum*, but none, other than *Laemophloeus*, was present in sufficient numbers to account for the heating.

In June 1943, an outbreak of *L. ferrugineus* occurred in Manitoba wheat stored in another Sharpness store since April 1940. In the two hot spots the grain reached 104° F., and at the end of July adult beetles were flying inside the shed. So far as the spread of *Laemophloeus* by flight is concerned, it was observed at Sharpness during the summer of 1949 that adult beetles had flown from infested granaries in the port to houses in the neighbourhood, sometimes to a distance of two miles.

An infestation at Sharpness of *L. minutus* and *L. ferrugineus* has been described by Finlayson (1950), with special reference to the biology of the Bethylid parasite *Cephalonomyia waterstoni* Gahan. The distribution of temperature and population of *Laemophloeus* sp. in a bulk of grain in a multi-floored warehouse at Sharpness has been recorded by Oxley and Howe (1944), who found that the greatest numbers of insects occurred in the favourable regions just outside the hottest zone.

INFESTATION IN NORTH-WEST ENGLAND

Birkenhead, 1944. In November 1944 at Birkenhead, six bins of Manitoba wheat stored in 45 open-topped concrete silos for periods of up to 12 months were found to be heavily infested by *Laemophloeus pusilloides* Steel & Howe. Temperatures were up to 95° F., and the original moisture content was 13–13·5 per cent. A detailed study of one bin of this grain has been published (Lucas and Oxley, 1946), in which it is suggested that the outbreak was due to the grain being infested when it was loaded into the bin. It seems that this infestation must have been acquired after the grain was shipped from Canada as the only species reported as responsible for outbreaks in Canada has been *L. ferrugineus*.

INFESTATIONS IN SCOTLAND

Glasgow, 1943. 1,300 tons of Manitoba wheat stored since August 1942 in concrete silos near Glasgow were found, in December 1943, to have a very heavy infestation of *L. ferrugineus*, accompanied by fair numbers of

O. surinamensis and some *C. oryzae*. The grain was caking on the surface and temperatures ranged from 65 to 117° F. The number of adult *Laemophloeus* ranged from 5 to 1,320 per lb. of wheat, and was highest in the area round the hot spot where the temperature was 93° F. The insects probably came from the endemic population of the silos.

Stirling, 1944. In March 1944, hot spots were detected in 5,000 tons of Manitoba wheat stored since July and October 1942 in a floor storage warehouse at Stirling. Storage arrangements were the same as at the warehouse at Newark already described. Some of the heating grain was removed and caked grain was discovered at floor level, where *Laemophloeus* sp. was found to be fairly numerous. In August a further set of hot spots developed and *Laemophloeus* sp. was then found distributed generally through the bulk in small numbers, and locally, at the hot spots, in very large numbers. On removal of the wheat further caking was found near floor level. This caking and that at Newark was almost certainly due to condensation of water, moving from the hot bulk, in a layer of grain cooled by contact with the floor.

Crieff, 1946. An outbreak of *L. ferrugineus* in home-grown wheat and oats, on a farm at Crieff in December 1946, has been described by Hall (1951). Temperatures ranged from 69 to 110° F., and the grain was sprouting. Conditions were very suitable for the development of *Piezostethus galactinus* (Fieb.) (Hemiptera : Anthocoridae) recorded at this farm for the first time in Scotland.

INFESTATIONS IN NORTHERN IRELAND

Belfast, 1942–46. O'Farrell and Butler (1948) state that *Laemophloeus* spp. infestations developed in dock silos in Belfast during the summer months of 1942–46. In a silo with wooden bins a succession of infestations by *Laemophloeus* occurred over a number of years. In January 1946 outbreaks of *L. ferrugineus* occurred in several bins in Manitoba wheat stored since June 1945. Temperature rose to 81° F., the grain on the surface being damp and mouldy. This grain was replaced in November 1947 with Hard Winter wheat, which, by February 1948, was showing temperatures of from 75 to 110° F. and large populations of *Laemophloeus*. This wheat was replaced by Russian barley in June 1948, and this grain, in turn, developed a heavy infestation by December 1948. One bin had a temperature of 100° F. The *Laemophloeus* in both cases had clearly come from the endemic population in the building.

OTHER INFESTATIONS IN THE UNITED KINGDOM

Although most of the outbreaks described here have been in Manitoba wheat, there have been others in English wheat, and in imported barley and maize, during the period covered. Manitoba wheat has no special susceptibility to attack ; it has been the only grain stored in bulk for long periods. Other grain was either stored in bags—a method of storage in which *Laemophloeus* alone does not seem to cause outbreaks—or it already carried a mixed infestation in which *Laemophloeus* was not dominant.

LAEMOPHLOEUS SPP. IN CANADIAN WHEAT

Similar infestations to those in the United Kingdom were found in Canada (McLaine, 1943 ; Smallman, in Anderson, 1943, pp. 41–4) when very large crops of wheat in 1941 and 1942 coincided with reductions in exports due to war conditions, and much wheat had to be stored in adapted buildings and in specially built bulk stores holding from 500 to 30,000 tons. After the war, when almost all the wheat once more passed through silo storage, there was little further trouble.

During the winter of 1950 and again in 1951 and early in 1952, however, a number of shipments of Manitoba wheat, all from western Canadian ports, were found, on arrival in the United Kingdom, to have substantial infestations of *L. ferrugineus*. Wheat shipped from the west provides exceptionally good conditions for showing up *Laemophloeus*, since the wheat is then locally increased in moisture by overstowing with timber, and the period of the voyage is much longer than from east coast ports.

The success of the control methods adopted by the Canadian authorities is shown by the fact that, with these exceptions, very few cargoes of Manitoba wheat were found to be infested to any appreciable degree. This is one of the principal reasons why outbreaks in this country are considered to have been caused by endemic populations and not by insects introduced with the grain.

ECOLOGY OF LAEMOPHLOEUS SPP.

From the descriptions of infestations in the United Kingdom and in Canada it is clear that the presence of *L. ferrugineus* and *L. minutus* in bulks of grain is associated with heating, caking and mould growth. The laboratory studies of Davies (1949), who gives references to the occurrence of *L. minutus*, *L. ferrugineus* and *L. turcicus* Grouv. on stored products, has shown that *L. minutus* is capable of raising the temperature of grain to well above the optimum of 30–35° C. when the initial insect population is 0·7 females per 100 cc. of grain. This density is considerably below that recorded from infested grain by various workers (Howe, 1943 ; Oxley and Howe, 1944 ; Lucas and Oxley, 1946).

One point difficult to explain is the build-up of local populations of *Laemophloeus* in sufficient numbers to start the process, particularly where the moisture content of the main bulk is low. The moisture content of Manitoba wheat on arrival in this country is usually from 12–13 per cent (60–65 per cent equilibrium relative humidity). Davies (1949) has shown that there is a high mortality of first instar larvae of *L. minutus* unless the relative humidity is above 90 per cent (22 per cent moisture content). Such high humidities may be produced in bulks of grain by small pockets of damp wheat or by entry of water through roof leaks or defects in floors and walls. *L. ferrugineus* does not appear to be so susceptible to low humidities as *L. minutus*. Rilett (1949) found mortality high at relative humidities below 50 per cent (11 per cent moisture content) and optimum conditions at 75 per cent relative humidity (15 per cent moisture content) and 90–100° F.

One aspect of the infestations described is the long period (from five months to three years) during which the grain had been in store before the infestations reached the stage of obvious heating. This is to be explained by the slow rate of development of *Laemophloeus* spp. at normal grain temperatures. The figures in the table below, which are adapted from Davies (1949) for *L. minutus*,

and from Rilett (1949) for *L. ferrugineus*, show that development for both species is slow at temperatures below 70° F.

PERIOD IN DAYS FROM EGG HATCH TO ADULT

Relative Humidity	Corresponding Moisture Content (at 70°F.)*	*Laemophloeus minutus* Temperature (°F.)					*Laemophloeus ferrugineus* Temperature (°F.)			
		62·6	69·8	77	86	95	70	80	90	100
per cent	*per cent*			*days*					*days*	
50	—	—	—	—	—	—	—	—	32·4	—
55	11·7	—	102·3	57·9	44·0	—	—	—	—	—
65	13·1	—	91·7	50·1	25·2	24·3	—	—	26·6	—
75	15·2	—	78·8	41·0	23·9	24·6	64·2	27·4	21·1	21·0
90	22·0	100·7	55·7	28·6	20·3	—	—	—	20·8	—
100	—	—	—	—	—	—	—	—	20·3	—

* For each 18° F. rise in temperature the moisture content drops by about 0·5 per cent (Gane, 1941).

It is clear that both species pass through their life cycles most rapidly at about 90° F. and at high relative humidities. As much grain in the United Kingdom goes into store at temperatures of less than 60° F., further study is necessary of the development of both species at such temperatures.

One of the problems of grain inspection is the difficulty of detecting infestations of *Laemophloeus* at a stage where control can be applied before heating and damage occur. Rilett (1949) has shown that *L. ferrugineus* will attack grain that is apparently sound, the larvae entering through microscopic breaks in the seed coat covering the germ region. Detection is made all the more difficult as the whole of the larval and pupal stages can be passed inside burrows in the wheat germ (Plate III, 3) and the adults also feed inside these burrows (Lucas and Oxley, 1946). Smallman (in Anderson, 1943, pp. 41–4) has suggested that the small numbers of insects in a large bulk tend to congregate at small pockets of moist grain. He suggests that in Canada such pockets may be caused by cracks at floor level in concrete flooring or by the opening of wooden floors. Some of the outbreaks in this country may have started in similar circumstances. The grain may also have been damped by roof leaks, by admixture of damp grain from hazards of carriage by ship, barge and rail and road transport, or by movement of water within bulks owing to differences of temperature between the main bulk of the grain and cool surfaces such as floors and stanchions. There is, however, no evidence that such damp spots have occurred in a number of *Laemophloeus* infestations described in this paper. The work of Rilett (1949) indicates that high humidities are not necessary for the development of *L. ferrugineus* which will develop at relative humidities of 50 and 65 per cent corresponding to moisture contents (at 70° F.) of 11–13 per cent.

CONTROL OF LAEMOPHLOEUS IN WHEAT

Control of infestations of *Laemophloeus* in suitable silos is not difficult; but for floor-stored bulks, particularly when there are steep temperature gradients such as occur in the advanced stages of infestations, control poses difficult

problems. Some success has been achieved in Canada by spot treatments with chloropicrin (Smallman, in Anderson, 1943, p. 44) and carbon tetrachloride (Smallman, in Anderson and Aitken, 1945, p. 40). During the earlier outbreaks that occurred in the United Kingdom no treatment other than removal of the grain was possible, but subsequent work carried on by the Infestation Control Division, and the Pest Infestation Laboratory of the Department of Scientific and Industrial Research, has indicated that general and spot treatment with carbon tetrachloride or mixtures of carbon tetrachloride and ethylene dichloride are effective. Methyl bromide is ineffective owing to poor distribution.

The descriptions of infestations given in this paper are based on the reports made by the Area Inspectors of the Infestation Control Division. The Division originally formed part of the Ministry of Food but in September 1947 it was transferred to the Ministry of Agriculture and Fisheries and to the Department of Agriculture for Scotland. The conclusions as to the origin of the infestation at Immingham were drawn by the Senior Inspector for the Area, Mr. J. D. Norris.

REFERENCES

ANDERSON, J. A. (1943). Sixteenth Annual Report, 1942. *Rep. Bd. Grain. Comm. Can.*, 1942, 33–4.

ANDERSON, J. A. and AITKEN, T. R. (1945). Eighteenth Annual Report, 1944. *Rep. Bd. Grain. Comm. Can.*, 1942.

DAVIES, R. G. (1949). The Biology of *Laemophloeus minutus* Oliv. (Col., Cucujidae). *Bull. ent. Res.*, **40**, 63–82.

FINLAYSON, L. H. (1950). The Biology of *Cephalonomia waterstoni* Gahan (Hym. Bethylidae), a Parasite of *Laemophloeus* (Col., Cucujidae). *Bull. ent. Res.*, **41**, 79–97.

GANE, R. (1941). The Water Content of Wheat as a Function of Temperature and Humidity. *J. Soc. chem. Ind. Lond.*, **60**, 44–6.

HALL, D. W. (1951). Observations on the Distribution, Habits and Life History of the Bug, *Piezostethus galactinus* (Fieb.) (Hem., Anthocoridae) *Ent. mon. Mag.*, **87**, 45–52.

HOWE, R. W. (1943). An Investigation of the Changes in a Bin of Stored Wheat Infested by Insects. *Bull. ent. Res.*, **34**, 145–58.

HOWE, R. W. (1951). A Note on Grain Pests of the Genus *Laemophloeus* (Col., Cucujidae), *Ent. mon. Mag.*, **87**, 161.

HOWE, R. W. and OXLEY, T. A. (1952). *Detection of Insects by their Carbon Dioxide Production. Publ. Dep. Sci. Ind. Res.*, H.M.S.O. London.

LUCAS, C. E. and OXLEY, T. A. (1946). Study of an Infestation by *Laemophloeus* sp. (Coleoptera, Cucujidae) in Bulk Wheat. *Ann. appl. Biol.*, **33**, 289–93.

MCLAINE, L. S. (1943). The War Activities of the Federal Divisions of Entomology and Plant Protection since 1939. *73rd Rep. ent. Soc. Ont.*, 1942, 7–16.

O'FARRELL, A. F. and BUTLER, P. M. (1948). Insects and Mites Associated with the Storage and Manufacture of Foodstuffs in Northern Ireland. *Econ. Proc. R. Dublin Soc.*, **3**, 343–407.

OXLEY, T. A. and HOWE, R. W. (1944). Factors Influencing the Course of an Insect Infestation in Bulk Wheat. *Ann. appl. Biol.*, **31**, 76–80.

REID, J. A. (1942). The Species of *Laemophloeus* (Coleoptera, Cucujidae) occurring in Stored Foods in the British Isles. *Proc. R. ent. Soc. Lond. A.*, **17**, 27–33.

RILETT, R. O. (1949). The Biology of *Laemophloeus ferrugineus* Steph. *Canad. J. Res. D.* **27**, 112–48.

STEEL, W. O., and HOWE, R. W. (1952). A New Species of *Laemophloeus* (Col., Cucujidae) associated with Stored Products. *Proc. R. ent. Soc. Lond. A.*, **21**, 86–8.

CHRYSANTHEMUM FLOWER DISTORTION SURVEY, 1951

Summarized by I. W. PRENTICE

Plant Pathology Laboratory, Harpenden, Herts

A disease which causes distortion of chrysanthemum blooms, sometimes accompanied by breaking of the flower colour, has attracted much attention in Great Britain recently, and this disease, which is thought to be caused by a virus or viruses, has been described under the name of Chrysanthemum Mosaic (Bewley and Richards, 1951 ; Skillman, 1951). Chlorotic line-patterns, mottles and other symptoms are not uncommon on chrysanthemum foliage in some seasons, but these are not usually associated with any flower distortion ; nor have any constant leaf-symptoms been found on plants with distorted flowers. It seems therefore that " Mosaic " is not an apt name for the disease, and " Chrysanthemum Flower Distortion " is proposed instead.

Diagnostic symptoms have been noted in flowers only and consist of " breaking " of the flower (white or yellow streaks on coloured petals) or distortion of the florets, as shown in Plate II, 1. The breaking, which is not seen on white or yellow flowers, may be slight or so severe on coloured varieties that the entire bloom appears bleached. Distortion may be of several kinds : the corolla may be rolled, or its edges may be joined so that it is tubular along most of its length ; or it may be twisted so that the inflorescence has an untidy appearance ; or varieties which are normally " incurved " may fail to incurve ; or the central florets may remain small and greenish. The inflorescence is usually much smaller than a healthy one, and of no commercial value.

By inoculation to suitable test plants, it can often be shown that chrysanthemum plants with distorted flowers are infected with the Tomato Aspermy virus (Blencowe and Caldwell, 1949). The occurrence of what appears to be this virus in chrysanthemums was first recorded by Ainsworth (1938) and it has since been reported by several other workers (Selman, 1940 ; Smith, 1949 ; Caldwell, 1951 ; Brierley and Smith, 1951). The virus is known to be transmitted from plant to plant by aphids. As the Aspermy virus is usually found in chrysanthemums with Flower Distortion, but not in normal plants, it is assumed that this virus is at least partially responsible for the disease, but proof of pathogenicity by infecting healthy plants and reproducing symptoms of Flower Distortion has not yet been given in the literature.

Environmental and cultural conditions affect the severity of the symptoms of some virus diseases and there is circumstantial evidence that this may be so with Flower Distortion. Symptoms certainly vary in severity in some varieties, and, while severe cases are easily recognized, it is difficult to diagnose mild cases with certainty. Again, some plants are carriers of certain viruses (i.e., the plants do not show symptoms when infected), and it may be that some varieties of chrysanthemum are carriers of Distortion ; there is, however, no evidence of this at present. Symptoms superficially similar to some forms of Distortion can be produced by other causes, for example, by damage by capsids, earwigs, mites or eelworms, and, in the presence of these pests, accurate visual diagnosis is difficult.

If only because of the difficulty of accurate diagnosis, it was impracticable to attempt a fully critical survey, but as some general indication of the prevalence and distribution of Flower Distortion in chrysanthemums was needed, a limited

general survey was made by County Horticultural Officers of the National Agricultural Advisory Service in nearly every county in England and in two counties in Wales late in 1951. For the purpose of the survey, the officers visited chrysanthemum growers' holdings in their respective counties, and reported on the apparent presence or absence of the disease and its relative prevalence in different varieties, so far as they could recognize it by visual symptoms.

With over fifty observers, a considerable variation in the standards adopted in diagnosing a relatively unfamiliar disease was only to be expected. Many officers, however, confirmed a proportion of their diagnoses by reference to their Provincial Plant Pathologist, and some 90 specimens were tested at the Plant Pathology Laboratory, Harpenden, by inoculation to *Nicotiana tabacum* and *N. glutinosa*. Eighty-three effective tests were made and the results of these were as follows :

Visual Diagnosis on Inspection	Number of Plants Tested	Aspermy Virus Present
Infected or probably infected	40	31
Doubtful or not infected	43	10

Some of the material was in poor condition when received through the post, and this may have resulted in failure to detect the virus in a few of the specimens. The inoculation tests agreed fairly well with the visual diagnoses, and indicated that on the whole these were accurate enough for the limited purposes of the survey.

According to the January 1952 Glasshouse Census, there are, in England and Wales, about 6,000 nurseries with over 1,000 sq. feet of chrysanthemums under glass. In the survey, examinations were made on more than 900 nurseries, most of which specialized to some extent in the production of chrysanthemums either as cut flowers or as plants. The counties were about equally well represented, and although the survey was called for when the majority of early flowering chrysanthemums were already passed, and therefore dealt mainly with mid-season and late varieties, there was no reason to believe that the infection in early varieties differed materially from that in later types. It seems, therefore, that the survey was wide enough in its scope to give a fair indication of the extent of the trouble in the country as a whole. In addition to the limited general survey by the Horticultural Officers, more detailed observations were made by Plant Pathologists on the nurseries of fifteen of the main distributors of chrysanthemum plants.

RESULTS OF SURVEY

Symptoms of Chrysanthemum Flower Distortion were found on about 75 per cent of the nurseries included in the general survey, except in the north, where the proportion was lower. In most of the nurseries only a few plants—much less than 1 per cent of the total grown—were infected, and infection was usually confined to a few varieties. Infection in individual varieties varied ; often it was under 1 per cent, but sometimes it was considerable, and some stocks were entirely infected.

In the special survey by the Plant Pathologists, the number of plants in bloom on two nurseries was too small to allow any definite conclusions to be drawn.

One nursery appeared to be free from infection ; doubtfully infected plants were found on two others, and plants showing symptoms of Flower Distortion were found on each of the remaining ten. In each case the amount of infection was very small, and usually only a few plants were affected in the whole of a large nursery. While, therefore, few if any of the main distributors of chrysanthemum plants have stocks entirely free from infection, the disease appears to be well under control in such establishments.

NUMBER OF INFECTED STOCKS OF SOME VARIETIES INCLUDED IN THE REPORTS

	Percentage Infection			
	0·1 to 5·0	*5 to 20*	*20 to 70*	*70 & over*
Agnes Ford	4	3	1	1
American Beauty & sports ..	7	4	2	4
Balcombe Perfection	7	0	1	2
Birmingham	3	4	2	2
Baldock's Crimson	0	2	2	3
Captain Kettle	2	2	2	2
Favourite & sports	43	28	26	17
Friendly Rival	9	3	1	6
Imperial Pink	4	3	1	1
Jane Ingamells	2	0	3	3
Lilac Wonder	1	0	3	4
Market Gold	1	4	3	1
Monument & sports	5	4	1	2
Shirley Late Red	7	8	3	5
Sussex Bronze	4	1	2	2
Sussex Red	6	2	6	1

The disease was recorded in nearly 200 different varieties altogether, but it has not been possible to draw definite conclusions on varietal susceptibility. Healthy stocks were often not mentioned by name in the reports, and, obviously, the more stocks of a variety that are grown, the greater the likelihood of some being diseased. Infection, however, does appear to be common in certain varieties, including American Beauty, Birmingham, Favourite, Friendly Rival, Market Gold, Sussex Red, and Shirley Late Red, as indicated in the above table.

GENERAL CONCLUSIONS

The surveys indicated that the disease is widespread in England and Wales, and not concentrated in any one area. There is a high percentage of infection in some stocks, but the average over the country is low. On many holdings infection was greatest in stocks which the grower had had for several years ; in equally as many cases, infection was greatest in recently purchased stocks. In general, infection was much lower on carefully managed and well-run holdings. This is no doubt largely due to the greater care exercised on such holdings in the selection of material for propagation, and to the more efficient removal of sub-standard material before spread of infection can occur. There were, however, several instances in which poor stocks were stated to have been purchased very recently from suppliers on whose holdings the disease appeared to be very rare. This suggests that such suppliers may recently have improved the standard of health of their stocks, or that symptoms are less easily distinguished in the cultural conditions found on the suppliers' nurseries. Instances occurred in which symptoms in a stock of a variety seemed to be more obvious or less obvious depending on the method of culture (pots or beds) or on the type of flower buds which had been " secured ".

(54037) A**2

Many and probably all varieties are susceptible, and the fact that infection is often largely confined to one or two on a nursery suggests that the rate of spread from plant to plant is not usually great. It is probable, therefore, that the high proportion of infected plants in some stocks is primarily due to the propagation of infected material. Indeed, in or one two cases it appeared that a diseased plant had been mistaken for a colour " sport " and had been specially selected for propagation. If the general percentage of infection is low and the rate of spread is moderate, there are good chances of controlling the disease by roguing combined with insect control. On the holdings of the specialist growers, selection, roguing and aphid control is already adopted to some extent, and the intensification of these methods might lead to the elimination of the disease on specialist holdings within a few years.

For the present, growers should be advised to select plants for propagation with the greatest care, when the plants are in flower. Enough plants with undoubtedly normal flowers should be marked so that they alone will be used for propagation later. If a grower's own stock of a variety is infected to a serious degree he would be well advised to destroy it and replace it from a reputable source.

It is possible, however, that the final control of this serious disease may prove more difficult than it at first appears. It is known that the Aspermy virus has a fairly wide host range although natural infection of plants other than chrysanthemums and tomatoes has not yet been found. If infection occurs on other plants, healthy chrysanthemums may become infected from them. Again, if symptoms in chrysanthemums are masked under certain environmental conditions, or if certain varieties can be infected without developing symptoms at all, then the difficulties of controlling and eliminating the disease will be increased.

Thanks are due to the many officers of the National Agricultural Advisory Service who supplied reports on which this summary is based ; and also to Mr. M. Hollings who carried out the inoculation tests at the Plant Pathology Laboratory. The photograph reproduced in Plate II, 1 was taken by Mr. W. F. Buck.

REFERENCES

AINSWORTH, G. C. (1938). Virus Diseases. *Rep. exp. Res. Sta. Cheshunt*, **24**, 60.

BEWLEY, W. F. and RICHARDS, A. A. (1951). A Mosaic Disease of the Chrysanthemum. *Gdnrs' Chron.*, **129**, 20.

BLENCOWE, J. and CALDWELL, J. (1949). Aspermy, a New Virus Disease of the Tomato. *Ann. appl. Biol.*, **36**, 320–2.

BRIERLEY, P. and SMITH, F. F. (1951). Survey of Virus Diseases of Chrysanthemums. *Plant Dis. Reptr*, **35**, 524.

CALDWELL, J. (1951). Further Observations on Chrysanthemum Virus Disease. *Gdnrs' Chron.*, **129**, 141.

SELMAN, I. W. (1940). A Virus Disease of Chrysanthemum. *Rep. exp. Res. Sta., Cheshunt*, **25**, 36–7.

SKILLMAN, E. E. (1951). Chrysanth Virus Needs Roguing. *Grower*, **35**, 65.

SMITH, K. M. (1949). Viruses and Virus Diseases. *J. R. hort. Soc.*, **74**, 525.

HOT-WATER TREATMENT OF CELERY SEED IN LANCASHIRE

by J. H. BANT AND I. F. STOREY

National Agricultural Advisory Service, Leeds

A hot-water seed treatment has for the past fifteen years given excellent results in the control of *Phoma lingam* (Fr.) Desm. on broccoli in the West Riding of Yorkshire. An account of this work, and of the arrangements made for seed treatment as a service to growers, has been given by Bant, Beaumont and Storey (1950). The effectiveness of a similar treatment for celery seed to control Septoria Blight was shown in America over thirty years ago (Krout, 1921), and although workers in other countries have confirmed this from time to time, no attempt had been made to apply it on any scale in this country until 1946, when celery growers on the moss lands of Lancashire were being troubled by severe outbreaks of Leaf Spot (*Septoria* spp.) despite the use of the formaldehyde seed treatment as recommended by Stirrup and Ewan (1931). The formaldehyde treatment was also liable to injure the seed, which from time to time completely failed to germinate. The use of celery seed free from *Septoria* is regarded as the ideal method of control, but at that time such " clean " seed was almost unobtainable. More recently the position has improved, but an examination of celery seed being used for sowing in Lancashire in 1951 showed that 39 out of 77 samples were infected. Twelve of these samples had more than 10 per cent infection.

COMPARISON OF CONTROL METHODS, 1949 AND 1950

In 1949 and 1950, plot trials were carried out in Lancashire with the main object of comparing the effectiveness of hot-water and formaldehyde seed treatments when used on severely infected seed. The hot-water treatment was the same as for broccoli (Bant *et al*, 1950). Hessian or muslin bags were half-filled with the seed (to allow for swelling) and then treated for 25 minutes in water maintained at 122° F. (50° C.). After treatment the seed was spread out to dry for several days in wooden trays lined with blotting paper. The formaldehyde treatment consisted in steeping the seed for 3 hours in a solution of 1 part of 40 per cent formaldehyde in 300 parts of water, with subsequent drying. In addition there were plots sown with untreated, and also with formaldehyde-treated seed, sprayed four or five times during the growing season with Bordeaux mixture (4.6.50), and also unsprayed plots sown with untreated " clean " seed, i.e., seed in which, on careful examination, we found no *Septoria*.

The plants were raised in frames and put out directly into their final position in the field. This is the common practice in Lancashire ; there is no intermediate pricking-out into plant beds as in some other celery-growing areas.

As severely infected seed was being used, it was considered undesirable to have replicated single rows, in some of which there would be diseased plants, scattered throughout the experimental area. Single plots were therefore used for each treatment, and these consisted of three rows of plants each 20 yards long. The plots were guarded by single rows of plants raised from " clean " hot-water treated seed, and were placed in fields of celery raised from hot-water treated seed. The crops surrounding the plots were not sprayed. The number of infected plants in each of the plots was counted from time to time during the growing season, and the percentage of plants showing infection in mid-October is given in Table 1.

In both years the degree of control obtained by the hot-water treatment was superior to that given by formaldehyde. The latter treatment reduced the number of badly infected plants, but the total infection was almost the same as on the untreated controls at the end of the season. Spraying with Bordeaux mixture without seed treatment gave some control, but it required the combination of formaldehyde seed treatment *and* Bordeaux spraying to give a control equal to or better than that obtained by the hot-water seed treatment alone, or by the use of " clean " seed.

TABLE 1

CONTROL OF SEPTORIA IN CELERY BY SEVERAL TREATMENTS, 1949 and 1950

Seed	Seed Treatment	Spraying	Percentage of Plants Infected	
			22.10.49	12.10.50
Clean	None	None	3	32
Infected*	None	None	29	78
Infected*	Hot water	None	5	2
Infected*	Formaldehyde	None	26	83
Infected*	Formaldehyde	Bordeaux	3	0
Infected*	None	Bordeaux	19	40

* 25 per cent infection in 1949 : 53 per cent in 1950

There was no evidence that the high percentage infection in the " clean seed " plot in 1950 was due to any infection of the seed. When this occurs there are often definite foci of infection, but here the slight infection was distributed throughout the plot, and it may well have been carried over from the adjacent plot, where the plants came from untreated and severely infected seed. The weather conditions during 1950 were very favourable for row-to-row spread.

FIELD OBSERVATIONS, 1951

In 1951, ninety-six lots of celery seed were treated with hot water for thirty-six growers. The seed as received was examined for presence or absence of *Septoria*, and germination tests were made before and after treatment.† The seed, much of which came from a common source, was treated for growers in two celery-growing areas, i.e., Hesketh Bank, near Southport, where there are many small growers with adjacent holdings, and South Lancashire (including Rixton, Cadishead and Glazebury mosses), where the areas of celery are larger and the growers less numerous.

Most of the crops from treated seed were kept under observation in both areas, and in October 1951, the extent of infection in crops from fifty-nine lots of treated seed was determined by taking samples of 10-yard lengths of row and counting the number of infected plants in them. The results are summarized in Table 2.

† The reduction in germination caused by hot-water treatment varies with the age of the seed ; in old seed it may be considerable, as indicated by the following results :

Harvest Year	No. of Samples	Average Germination before Treatment *per cent*	Reduction in Germination due to Treatment *per cent*
1950	3	86	2
1949	14	84	4
1948	10	68	18

Hot-Water Treatment of Celery Seed

Septoria infection in plants raised from hot-water treated seed was found to be confined to the Hesketh Bank area. The amount of disease in the field bore no relation to the amount of disease in the seed before the hot-water treatment. In the fields showing disease, the mean percentage of plants infected was 7 per cent in crops from seed infected with *Septoria* before treatment, and 8 per cent in those from seed free from *Septoria*. The results suggest that the infection did not come from the seed but from some other source. The conditions in the Hesketh Bank area are very favourable for field-to-field spread : the many small adjacent holdings are near the sea and subject to high winds and driving rain. Two badly infected crops from untreated seed were found in the area, and there may have been spread from them. Gapping-up with plants from an infected stock probably accounted for infection in at least one of the fields.

Table 2

Septoria Infection in Crops Grown from Hot-Water Treated Seed

Area	Seed Apparently Free from *Septoria* before Treatment		Seed Infected with *Septoria* before Treatment	
	Total No. of Crops	*No. Infected in October*	*Total No. of Crops*	*No. Infected in October*
Hesketh Bank	22	4	13	7
South Lancs	10	0	14	0

The hot-water treatment of celery seed has given most promising results under Lancashire conditions, and it has demonstrated the possibility of obtaining clean crops from severely infected seed by this means alone, provided care is taken to prevent infection from outside sources. Where possible the seed should be hot-water treated within a year of harvest ; the treatment may cause considerable reduction in germination in old seed.

Grateful acknowledgment is made to Mr. J. W. Ewan, Horticultural Officer for Lancashire, and his staff, for their help in supplying seed samples and arranging trial centres ; and to Mr. A. Beaumont for his continued interest and encouragement in the work.

References

Bant, J. H., Beaumont, A., and Storey, I. F. (1950). Hot Water Treatment of Broccoli Seed. *N.A.A.S. quart. Rev.*, No. 9, 43–6.

Krout, W. S. (1921). Treatment of Celery Seed for the Control of Septoria Blight. *J. agric. Res.*, **21**, 369–72.

Stirrup, H. H. and Ewan, J. W. (1931). Investigations on Celery Diseases and their Control. *Bull. Minist. Agric. Fish. Lond.*, No. 25.

A NEW BACTERIAL DISEASE OF LEEKS

by R. A. LELLIOTT

Plant Pathology Laboratory, Harpenden, Herts

In June, 1949, Mr. H. H. Glasscock of the National Agricultural Advisory Service at Wye, received from two farms, one near Canterbury, Kent, and the other in East Sussex, leek flowering stems with long, water-soaked lesions. On examining the East Sussex crop in July 1949, he estimated that of the 27 acres of leeks being grown for seed, 10 per cent of the stems were affected—5 per cent severely—and that later in the season the proportion reached 50 per cent. Badly attacked stems did not set seed and there was a spotting of the leaves, which he associated with the stem lesions. Specimens of the diseased stems were sent to Dr. W. J. Dowson of Cambridge who isolated a species of *Pseudomonas* Migula emend. Dows. which produced symptoms on excised pieces of flowering stem very similar to those observed in the field. Long streaks on the leaves and withered tips were produced on young leek plants sprayed with this isolate. A bacterium identical with the original isolate was recovered. Dr. Dowson considered that his isolate was closely related to *P. coronafacians* (Elliott) Stapp, and to *P. berberidis* (Thornberry & Anderson) Stapp, but he was unable to infect young leek plants with either of these organisms.

The disease was not recorded in 1950, but in late July 1951, I examined another infected crop of leeks on the East Sussex farm. On 25 per cent of the stems there were small, sometimes confluent, circular, olive green, water-soaked lesions 2–15 mm. in diameter, the larger of which had light brown centres (Plate I, 1). Much larger, light brown to brown, water-soaked lesions up to 25 cm. in length, with olive green edges, were also present, sometimes girdling the stem but more often confined to one side of it (Plate I, 2). Looped and crank-shaped distortions of the stem were numerous, and these appeared to be the result of an infection of young, rapidly-growing stems, slowing or stopping growth on one side. No lesions were observed on the leaves.

Suspensions of tissue from young lesions were streaked on plates of heart diffusion-peptone agar and these resulted in almost pure cultures of a species of *Pseudomonas*. In late August, the mature stem of each of three leek plants was sprayed from an atomiser with a water suspension of a pure culture of this organism, and the inoculum was protected from desiccation by a thin, transparent plastic envelope, held away from the stem by a spiral of wire. Three other stems were similarly treated after scoring with a sterile scalpel in the area to be inoculated. Finally, three unwounded plants were inoculated but not covered. Three control plants for each treatment were sprayed with sterile water. The transparent envelopes were removed after 48 hours. After 21 days, lesions of the larger type already described, tailing off into the smaller type, had appeared on the wounded plants, and on one of the three unwounded, initially covered stems there were 13 of the smaller lesions. No lesion appeared on the control plants or on the unwounded stems which had not been covered. The bacterium inoculated and that reisolated from the lesions were culturally and biochemically identical.

No reference has been found in the literature to a similar bacterial disease of leek. Further work is being carried out on the identity and biology of the pathogen.

The photographs were taken by Mr. W. C. Moore.

1. Weakened and dwarfed plants in part of an infected crop. A lesion has girdled one of the stems in the foreground.

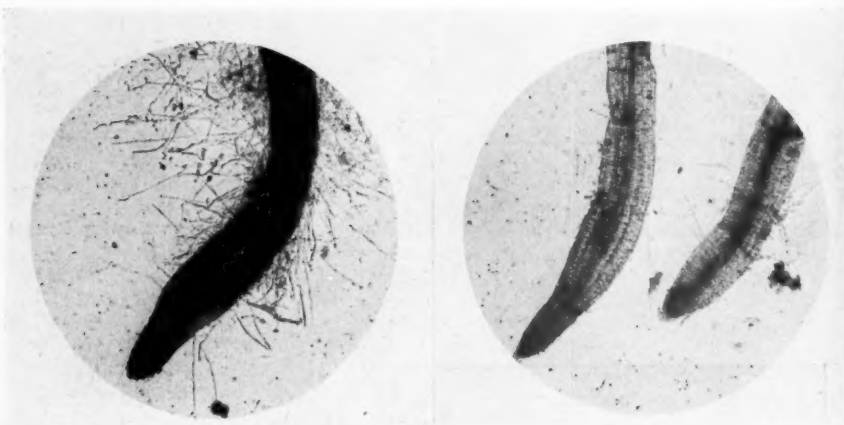
2. Natural infection of a young leek stem showing discrete and confluent lesions.

PLATE I

CHRYSANTHEMUM FLOWER DISTORTION (*see pp. 77–80*)

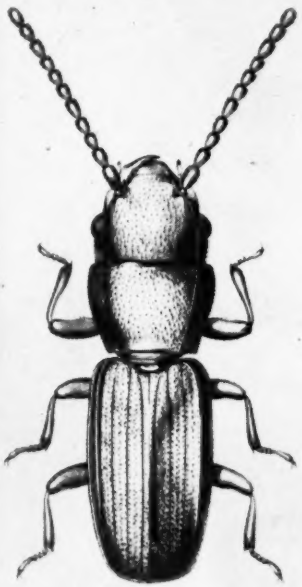
1. Two blooms showing typical distortion of the florets.

SYMPHILID DAMAGE TO TOMATOES (*see pp. 87–8*)



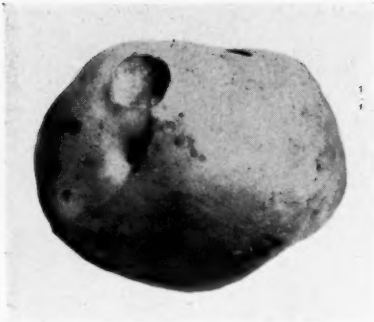
2. *Left* : Tomato roots showing abundance of root hairs where parathion was used for control of symphilids.

Right : Removal of root hairs by symphilids in untreated plants. Magnification × 20.



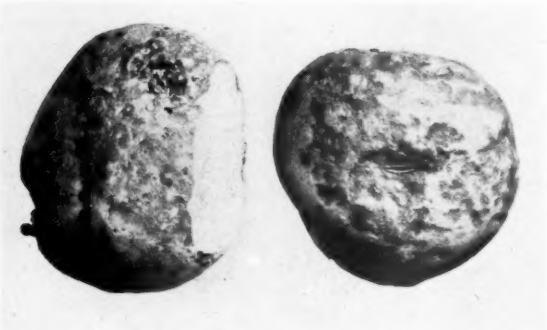
1. *Top :* Caking of wheat in store due to heating as a result of *Laemophloeus* infestation.
2. *Left :* The Rust-Red Grain Beetle (*Laemophloeus ferrugineus* Steph.) × 35
3. *Right :* Typical damage to grain, with burrowing in germ area.

PLATE III



1. Gangrene (*Phoma foveata*), early stage, showing typical " thumb mark ".

2. Gangrene (*Phoma foveata*), advanced stage, lesion with pycnidia on surface.



3. Skin Necrosis, associated with *Phoma foveata*. Arran Banner.

4. Skin Necrosis, associated with *Phoma foveata* and *Phoma eupyrena*. Arran Banner.

5. Skin Necrosis, associated with *Phoma eupyrena*, showing smooth dark type of lesion resembling blight. Alness.

PLATE IV

THE DISTRIBUTION AND PREVALENCE OF POTATO GANGRENE

by C. E. FOISTER

Seed Testing, Plant Registration and Plant Pathology Station, East Craigs, Edinburgh

Although Gangrene of potato due to *Phoma foveata* Foister (1940) was first described in 1936 (Alcock and Foister, 1936), it was then evident that the disease had been present in Scotland for many years, but that it had been confused with Dry Rot (*Fusarium caeruleum* (Lib.) Sacc.). A survey in 1936 showed that it was distributed in all the seed-growing areas in Scotland. The majority of the stocks of tubers in which it was found showed only trivial infection, but in a few there was up to 80 or even 100 per cent. Since 1936, outbreaks of the disease have been sporadic, although some infected tubers could be found every year. It would appear that the disease is favoured by wet seasons, whereas Dry Rot is favoured by dry ones. In Scotland, Gangrene was severe in the winters of 1935–36, 1940–41, 1941–42 and 1950–51, when the weather was unusually wet in two out of the three months from August to October. It is now suspected that both Gangrene and Dry Rot were responsible for the severe losses in Doon Star in 1927—also a wet year.

A form of Dry Rot associated with a species of *Phoma* (thought to be *P. tuberosa* Melh., Rosenb. & E. S. Schultz) was reported in 1923 in Yorkshire and Caernarvonshire and in 1924 in Berkshire (Pethybridge, 1926). What may have been the same disease was reported from England, on Scotch seed, in 1929, and on ware tubers in Lincolnshire in 1930 (Pethybridge, Moore and Smith, 1934). It was not then considered to be common or of economic importance. At one time a frequent remark was that " Gangrene surely stopped at the Border ", because none was apparently seen to the south, but since 1938 there have been a few records of its occurrence on potatoes grown in England and Wales (Moore, 1943 and 1948).

Experience in Scotland suggests that *Phoma foveata* is probably ubiquitous, but infections by it, or by *P. eupyrena* Sacc. (see below), are not always recognized ; and, moreover, injury to tubers in transit promotes the development of Gangrene. These two facts may explain why it seems to be most frequently reported in seed that has been transported by rail. The usual story is that seed potatoes show no sign of the disease when dispatched, or when received by the consignee, and yet much Gangrene is noted when the seed is dressed prior to planting. Much of the disease is overlooked in the rush to prepare seed for planting ; and much is undoubtedly passed at that time as Dry Rot, and occasionally as Blight. The disease does not develop early in the winter, but is usually encountered from January onwards, often with considerable development even in April. The typical appearance of Gangrene lesions in their early and advanced stages is shown in Plate IV, 1 and 2. Wounding and bruising of the tubers leads to increased development of Gangrene, as it does of Dry Rot, but Gangrene is not completely dependent upon wounds, for infection of the uninjured skin can take place under moist conditions. Whereas most outbreaks of Dry Rot occur where there has been a history of potato cultivation, Gangrene is frequently found on crops grown on virgin land.

Neither Gangrene nor *Phoma foveata* has been recorded outside Great Britain and Northern Ireland, although symptoms somewhat similar to Gangrene have been ascribed in Europe, Canada and the U.S.A. to *Phoma eupyrena*

Sacc., *Phomopsis tuberivora* Güss. & Foster, and *Phoma tuberosa* Melh., Rosenb. & E. S. Schultz, respectively. In Scotland, *P. eupyrena* has frequently been isolated from Gangrene lesions and has reproduced the disease on inoculation into healthy tubers.

GANGRENE AND SKIN NECROSIS

Species of *Phoma* have frequently been found in association with the condition known as Skin Necrosis (Moore, 1943, p. 24). Here the lesions are very shallow, dark and irregularly shaped, with a superficial resemblance to Blight. They are usually extensive, covering perhaps one quarter of the surface, but occasionally the whole tuber is involved. The margins are well defined and often their surface is uneven (Plate IV, 3, 4 and 5). Skin Necrosis cannot always be attributed to Gangrene, but undoubtedly it is often a form of the disease in which the fungus penetrates only into the superficial tissues just under the skin. Sometimes the pycnidia developing on Skin Necrosis lesions are those of *P. foveata*, and sometimes of *P. eupyrena*, and even when pycnidia are absent, one or other of these fungi can often be isolated. If tubers affected with Skin Necrosis are kept for observation under damp conditions, in soil or otherwise, the lesions will often be found to increase in size.

VARIETAL AND SOIL FACTORS

Most of the common potato varieties have been found to be affected with Gangrene at one time or another. Those most often infected, sometimes very severely, are Majestic, Home Guard and Arran Pilot, but the disease has occurred naturally on many other early and early maincrop varieties ; among the late maincrop varieties it has been seen on Arran Cairn and Kerr's Pink. Skin Necrosis has also been seen on a number of early and early maincrop varieties.

In several instances both Gangrene and Skin Necrosis have been severe in crops grown on land slightly to markedly deficient in phosphate, potash and nitrogen. In one case, in which Arran Banner showed almost 100 per cent infection with Skin Necrosis and Gangrene, the soil was very acid and impoverished, the farm being of a marginal land type. In another, Arran Viking was grown on almost pure sand on the shore of the Solway ; the stock was sent to England in January in perfect condition, yet 70 per cent developed Gangrene in February, while the home-saved seed portion remained satisfactory.

REFERENCES

ALCOCK, N. L. and FOISTER, C. E. (1936). A Fungus Disease of Stored Potatoes. *Scot. J. Agric.*, **19**, 252–7.

FOISTER, C. E. (1940). Descriptions of New Fungi causing Economic Diseases in Scotland. *Trans. bot. Soc. Edinb.*, **33**, 65–8.

MOORE, W. C. (1943). Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1933–42. *Bull. Minist. Agric. Lond.*, No. 126, 18.

MOORE, W. C. (1948). Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1943–46. *Bull. Minist. Agric. Fish. Lond.*, No. 139, 23.

PETHYBRIDGE, G. H. (1926). Report on the Occurrence of Fungus, Bacterial and Allied Diseases of Crops in England and Wales for the Years 1922–24. *Misc. Publ. Minist. Agric. Fish. Lond.*, No. 52, 28.

PETHYBRIDGE, G. H., MOORE, W. C. and SMITH, A. (1934). Report on Fungus, Bacterial and other Diseases of Crops in England and Wales, 1928-32. *Bull. Minist. Agric. Fish. Lond.*, No. 79, 32.

SYMPHILID DAMAGE TO TOMATOES

by L. N. STANILAND AND L. E. W. STONE

National Agricultural Advisory Service, Bristol

A number of cases of long-standing trouble with " root-death " of tomatoes under glass, not attributable to primary attack by soil fungi, have now been investigated in the South-Western Province—notably in the Minehead, Cheddar, Frome and Keynsham districts of Somerset, near Westbury in Wilts, and in the Wimborne district of Dorset. There has also been one case on outdoor tomatoes. When affected plants were first examined—in May, June and July 1950—only a few symphilids (*Scutigerella immaculata* Newport) were found near the rotting roots, but this led us to suspect symphilid damage earlier in the season.

In the following year we returned to the houses where the trouble occurred and examined the young plants in the spring. We found that the number of symphilids about the roots could readily be estimated by lifting the plant with a ball of soil attached and rapidly lowering the whole into a bucket of water. Moving the plant up and down generally served to wash the soil off the roots, but where the soil was very sticky it was kneaded gently with the fingers below water. The symphilids, being very waxy, floated on the surface of the water, where it was easy to count them and to detect dead individuals.

By these means it was found that the young tomato plants attracted symphilids to their roots within three to four days of being set out in the houses. The number per plant, at this stage, was very much greater than in May to July—commonly 50 to 100, and often several hundreds. Small reddish-brown lesions could be found in large numbers on the roots and it seemed probable that these lesions were caused by the symphilids and might well make the roots susceptible to fungus attack. Symphilids feed on the root hairs, and the absence of these hairs was found to be a useful diagnostic symptom of symphilid infestation (Plate II, 2).

Preliminary experiments were then made on means of controlling the symphilids, and on the effect of such control on the subsequent health of the root systems. Very thorough steam sterilization was tried at one centre, but it was soon evident that only slight control was effected, although the soil was kept warm, and the symphilids were attracted to the surface by a crop of rape taken before steaming.

PREVENTING INFESTATION OF YOUNG PLANTS IN POTS

It was found that newly-potted plants placed on infested soil in the propagating house rapidly became infested through the bottoms of the pots. Where infestation was permitted to occur in this way, root-death was found to be widely and more or less evenly distributed over all the houses in which the plants were set out. Where the pots were kept on stagings and not allowed to make contact with infested soil before being set out, the root-death was much more patchy in its distribution, and some areas remained free. Infestation in the pots, besides causing much extra damage in the early stages of growth, was also responsible for spreading the pest about the houses. A simple means of preventing this was soon found. A small piece of cotton wool placed over the hole inside the pot, before potting-up, was effective in preventing the entry of symphilids ; and an alternative was to stand the pots down so that the holes rested on small external pieces of the cotton wool. The cost of the cotton wool was only about five shillings for 3,000 plants.

BALL-WATERING WITH INSECTICIDES

A week after planting out the attraction of symphilids to the roots of the young plants appeared to be almost complete, since very few of the pests could then be found in the soil away from the plants. Ball-watering of the plants with insecticides was therefore tried at this stage, each plant having been set in a shallow depression to facilitate the penetration of the fluid to the root system. In 1951, trials were made in one large house with six materials, using blocks of fifty to a hundred plants for each treatment, and applying one pint per plant throughout. The materials used, and results obtained, were as follows :

Mercuric chloride. 1 oz. per 10 gal. of water. Complete kill of symphilids within a few days ; but plants definitely hardened and checked. Good root growth after three weeks, and markedly better than controls.

HETP (64 per cent). 1 fl. oz. per 10 gal. of water. No kill of symphilids ; no hardening of plants ; root damage continued.

DDT (20 per cent) (wettable powder). 3 oz. per 10 gal. of water. Complete kill of symphilids, though not so rapid as with mercuric chloride. Some hardening of the plants, but less than with mercuric chloride. Subsqeuent root growth good.

Schradan. 1 fl. oz. per 10 gal. of water. Fair kill of symphilids, but not so good as DDT or mercuric chloride. No hardening of the plants, and subsequent root growth fairly good.

Parathion (20 per cent). 1 fl. oz. per 10 gal. of water. Complete and rapid kill of symphilids ; no hardening of the plants, and root growth outstandingly better than with any of the other treatments, the roots being exceptionally white and clean.

Control. Plants continued to be heavily infested ; root growth extremely poor and roots much discoloured.

BHC. This was not included in the trial. Used at another centre, as wettable powder, it gave good control of symphilids but caused marked hardening of the plants.

As the parathion treatment was found to be outstandingly effective in this trial, it was used experimentally in other houses and on larger areas. In all cases it prevented the root-death, and the plants did not suffer their usual decline in May and June, but continued in normal healthy growth, which was reflected in increased yields. The cost of watering 12,500 plants with parathion was approximately £3 10*s*., excluding labour. The work is continuing, and the effects of watering with weaker solutions of parathion remain to be explored.

We suggest that, where symphilids are thought to be present in sufficient numbers to be injurious, extra seedlings should be planted between the rows when setting out the houses. A few of these plants can be lifted daily, and tested for symphilids by the " bucket " method. Parathion watering can then be applied if it is considered necessary. The extra plants can also be treated, examined to check the kill, and then removed. Growers using parathion should be warned to take all the precautions necessary in the handling of this organophosphorus insecticide. (See the Ministry of Agriculture and Fisheries' Advisory Leaflet No. 374, *Precautions in the use of Insecticides, Fungicides and Weed-killers.*)

Thanks are due to Mr. C. A. T. Edwards for the photographs.

THE RAPID ASSESSMENT OF APPLE SCAB ON FRUIT

by H. E. CROXALL, D. C. GWYNNE AND J. E. E. JENKINS

National Agricultural Advisory Service, Newcastle-on-Tyne and Evesham

The assessment of Apple Scab (*Venturia inaequalis* (Cooke) Wint.) on leaves provides valuable information on the progress of scab during the season, but, for the estimation of the economic loss caused by the disease, assessment of scab on the fruit is essential. Two methods of assessment are here outlined. One is a standard diagram method, used at or after picking, by which the actual amount of scab on the fruit may be determined, and an indication of the economic loss can be obtained. The other is a visual method, using a key similar to that for scab on leaves (Croxall, Gwynne and Jenkins, 1952) by which the progress of scab development on the fruit may be followed during the growing season.

STANDARD DIAGRAM METHOD FOR PICKED FRUIT

Marsh (1947) published a method for calculating the amount of scab on fruit by comparisons with standard diagrams. We have found it desirable to modify this method, by increasing the number of categories, as shown in Fig. 1, to cover the economically important range of infection. Scabbed area above 1 per cent exceeds the maximum blemish tolerated for " Fancy R " grade dessert apples, and over 3·5 per cent exceeds the maximum amount of blemish allowed for even " Domestic R " grade cooking apples.

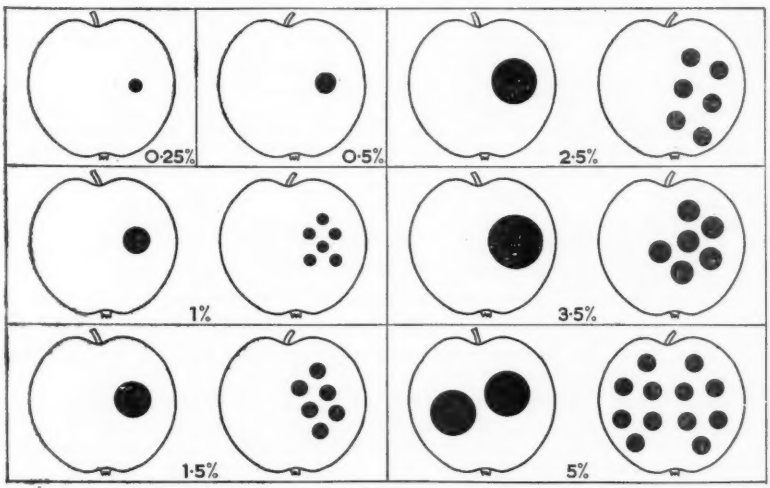


Fig. 1. Standard Diagrams for assessment of Apple Scab on fruit (the spots represent the amount of Scab on the whole surface area, not on the uppermost half only).

In the diagrams the spots represent percentages of the *total* surface area of the fruit, for by rotating the apple the total scabbed areas can usually be seen at a glance. When this is impossible, each half of the apple should be assessed

separately and the two figures added. The diagrams may be used in two ways. One method is to match apples to the nearest diagram, e.g., to take 3·5 per cent as covering the range from about 3·0 to about 4·25 per cent. The other method is to regard each diagram as representing the upper limit of a group, e.g., 3·5 per cent as the upper limit of that ranging from 2·5 to 3·5 per cent, so that any apple from just over 2·5 to 3·5 per cent infected falls into this category, the mean of which is 3 per cent. This latter method is used for grading fruit commercially, and with irregular intervals between the percentages illustrated in the diagram it is likely to give a more accurate result. With either method the mean percentage scabbed area is calculated by multiplying the number of apples in each group by the mean scab percentage for the group, adding these figures, and dividing the total by the total number of apples assessed.

COMPARISON OF ASSESSMENTS BY VISUAL KEY* AND STANDARD DIAGRAMS

In 1951, assessments using the visual key were made in a spraying trial on Worcesters at Holt, Worcestershire, and in several other orchards in Worcestershire, County Durham, and Northumberland, in order to observe as wide a range as possible in amounts of scab. Random samples of 100 fruits from the same trees were then assessed using the standard diagrams in Fig. 1, and regarding each diagram as representing the upper limit of a grade :

By Standard Diagram ..	1·25	1·15	0·86	1·13	0·39	0·36	0·34	0·25	0·18
By Visual Key	1·70	1·00	1·26	1·25	0·50	0·50	0·32	0·19	0·10

These results show reasonable agreement between the two methods. Further study is now needed over a wider area and for several seasons.

*KEY FOR APPLE SCAB ON FRUIT

If leaf assessments have been made, the same trees should be used. If not, recordings should be made, where possible, on 10 trees for each variety, uniformly distributed throughout the plantation. On each tree five runs of branches, chosen at random round the tree, should be taken as sampling units. Assess each tree separately and take the mean.

Scab *per cent*	
0·01	Occasional units show one or two fruits infected.
0·1	Small scab spots on one or two fruits in each unit.
0·5	Small scab spots on about one-quarter of the fruits in each unit.
1·0	Up to 5 small scab spots on about one-half of the fruit in each unit. No cracking.
5·0	Scab spots on about three-quarters of the fruit in each unit. Occasional fruits may be cracked.
10·0	Every fruit in each unit shows scabbed areas with a few cracking.
25·0	Every fruit in each unit shows large scab spots with up to a quarter of the fruits cracked. Fruit more variable in size and, on the whole, slightly smaller than fruit from healthy trees.
50·0	Every fruit in each unit shows large scab spots with about one-third of the fruit severely cracked and of non-marketable grade. Fruit generally smaller than that from healthy trees.
75·0	Every fruit in each unit shows large scab spots with about one-half of the fruit severely cracked and of non-marketable grade. Fruit appreciably smaller than that from healthy trees.

Blemishes other than Scab, such as Capsid damage, Brown Rot, etc., should be noted.

Rapid Assessment of Apple Scab

Percentage of Scab on Fruit in Relation to Market Grading

Mean percentage scabbed area is a convenient way of expressing briefly the amount of disease in a crop but it does not necessarily convey any idea of the economic loss. A guide to this, however, was provided, before the last war, by the Statutory Grades under the Agricultural Produce (Grading and Marketing) Acts. These gave the permitted amount of non-progressive blemish for various commercial grades of fruit. The blemishes included frost damage and insect injury but among the more important were those due to apple scab. Since the end of the war, interest in apple grading has revived and new recommended grades were authorized in 1948. These are illustrated and brought up to date in the current Marketing Guide No. 30 (1951).

Maximum Amount of Blemish Permitted in Apple Grades

Grade	Dessert Varieties	Cooking Varieties
"Extra Fancy R" ..	None	None
"Fancy R"	Up to $\frac{3}{8}$ in. square (0·9%)	Up to $\frac{1}{2}$ in. square (1·5%)
"Domestic R" ..	Up to $\frac{5}{8}$ in. square (2·5%)	Up to $\frac{3}{4}$ in. square (3·5%)

The figures in brackets indicate percentage surface area affected in apples of approximately $2\frac{1}{4}$ inches diameter, as shown in the marketing leaflet. In practice, apple packers tend to compare the appearance of the apples with the diagrams, rather than to estimate the actual area blemished. An attempt has therefore been made to see if there is any correlation between the distribution of apples into the recommended grades and the mean percentage scabbed area for the crop. The mean percentage scabbed area was calculated by using the standard diagrams for samples of 100 apples. Ignoring blemishes other than scab, the apples were then assigned to the various recommended marketing grades :

Grading of 17 Samples of 100 Apples in Relation to Mean Percentage of Fruit Area Scabbed

Mean Percentage of Fruit Area Scabbed	Grading of Sample			
	"Extra Fancy R"	*"Fancy R"*	*"Domestic R"*	*Culls*
Dessert Varieties				
2·19	1	35	42	22
2·15	6	39	34	21
1·13	21	38	29	12
0·46	47	40	11	2
0·39	40	49	10	1
0·35	50	41	8	1
0·25	64	29	7	0
0·25	65	30	4	1
0·24	67	26	6	1
0·16	78	17	5	0
Cooking Varieties				
1·25	28	48	12	16
1·15	16	64	14	6
0·86	28	44	24	4
0·39	52	44	2	2
0·35	48	44	6	2
0·34	44	52	0	4
0·18	62	34	4	0

The results indicate that, for the crops examined, apple samples with approximately the same percentage mean scabbed area graded similarly. With up to 0·25 per cent mean scabbed area for dessert fruit, about two-thirds of the crop was " Extra Fancy R ", with almost no culls, and only about one-twentieth " Domestic R " grade. From 0·25 per cent to 0·5 per cent there were again almost no culls but approximately one-tenth was " Domestic R " and the remainder more or less equally divided between the " Extra Fancy R " and " Fancy R " grades. Above 0·5 per cent represents a high level of scab and few crops with this amount were seen. At 1·25 per cent nearly one-third of the crop was " Domestic R " grade and one-eighth culls. At 2 per cent scab there were almost no " Extra Fancy R " fruit and one-fifth of the crop was below market grade. Similar relationships existed for the cooking varieties.

Further work is needed to ascertain whether such a correlation exists over a wide range of crops and seasons. In the meantime, for routine survey work where it is unnecessary to detect small differences in the amount of scab, assessment using the two diagrams which correspond to the " Fancy R " and " Domestic R " levels for dessert or cooking apples as the case may be, appears to offer a simple means of obtaining a direct measure of the economic loss due to the scab attack. Moreover, the mean percentage scabbed area may be calculated from these results if it is desired to express the amount of scab by a single approximate figure.

REFERENCES

CROXALL, H. E., GWYNNE, D. C. and JENKINS, J. E. E. (1952). The Rapid Assessment of Apple Scab on Leaves. *Plant Pathology*, **I**, 39–41.

MARSH, R. W. (1947). Fruit Spraying Trials with Certain Recently Introduced Fungicides. *J. Pomol.*, **23**, 185–205.

Ministry of Agriculture & Fisheries (Marketing Division). (1951). National " Recommended " Grades for Trial Use for Home-Grown Apples. *Marketing Guide No.* 30.

THE IDENTIFICATION OF APHIDS OF ECONOMIC IMPORTANCE*

by H. L. G. STROYAN

Department of Zoology, University of Cambridge

NASONOVIA Mordvilko

The synonymy of the species of this genus is very complicated. The most important species, *Nasonovia ribis-nigri* (Mosley) is described by Theobald (**1**, 302) as *Myzus lactucae* Schrank ; a more recently used synonym has been *N. ribicola* (Kalt.).

---

* Continued from *Plant Pathology*, 1952, **I**, 42–8.

GENERIC CHARACTERS

Medium-sized green or reddish, rather shiny aphids with a well-marked dorsal sclerotic pattern. Frontal outline in apterae rather W-shaped, with distinct lateral and median prominences. Antennae rather long, processus terminalis usually more than five times as long as basal part of VI ; III nearly smooth : secondary rhinaria rather protuberant, present in apterae on basal one-quarter to three-quarters of III only ; much more numerous in alatae and placed all along III, with a variable number also on IV. Rostrum with apical joint rather long and slender, almost parallel-sided. Dorsal sclerotic pattern of apterae normally distinct ; it consists of pigmented paired intersegmental muscle plates with a varying amount of suffused pigmentation surrounding them and extending over the mid-dorsum. In small and early spring, on specimens of (on Ribes) *N. ribis-nigri*, however, the pigmentation is often very weak or absent. In alatae there are blackish tubercle-bearing marginal sclerites from abdominal segments 2–4, well-defined ante- and postsiphuncular sclerites and often dark segmental bars connecting the muscle plates on abdominal segments 3–5; the whole pattern bears a marked resemblance to that of *Aulacorthum solani*. The marginal tubercles are not always present. The spinal and pleural hairs of the abdomen are conspicuous and very regularly arranged in pairs. Spiracles rather large and widely open. Siphunculi rather long, cylindrical, nearly smooth, without or with very little apical reticulation, but with a distinct pre-apical annular circumcision. Cauda elongate, rather blunt finger-shaped, usually with 6 to 8 hairs in lateral pairs with or without a single subapical hair.

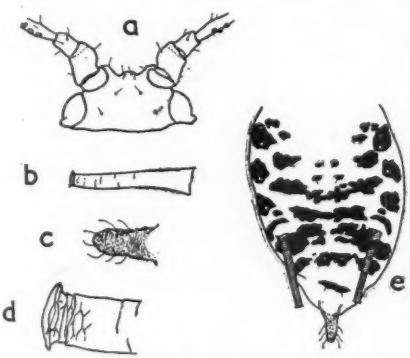


Fig. 11. *Nasonovia ribis-nigri* (Mosley), apt. v. ♀.
a. Head. b. Siphunculus. c. Cauda.
d. Apex of siphunculus, further enlarged.
e. Abdominal pattern of al. v. ♀.

ECONOMY

The only important species is *N. ribis-nigri* (Mosley), which is heteroecious between *Ribes* and various Compositae, among which the most important are lettuce and chicory ; others are *Crepis* and various species of *Hieracium*. In addition to Compositae, *Veronica* may also be colonized in summer. On *Ribes* it may be distinguished from *Hyperomyzus* spp. by the cylindrical siphunculi, and from *Cryptomyzus* by the absence of marked capitate hairs ; on lettuce it may be separated from *Aulacorthum solani* by the W-shaped frons and presence of more rhinaria on ant. III in the apterae.

LITERATURE : Hille Ris Lambers (*Temminckia*, **8**, 306).

PENTATRICHOPUS Börner

There are three British species, *P. fragaefolii* (Cockerell), *P. potentillae* (Walker) and *P. tetrarhodus* (Walker). Theobald (1912, *Entomologist* **45**, 223) described *P. fragaefolii* as *Myzus fragariae* and later (**1**, 244) as *Capitophorus fragariae*. It is now considered that *C. fragariae* (Theobald) is a synonym of *P. fragaefolii* (Cockerell).

It is probable that *Pentatrichopus* should be regarded as a sub-genus of *Chaetosiphon* Mordvilko. The latter genus contain certain Asiatic and high alpine species which have capitate hairs on their siphunculi, but otherwise resemble *Pentatrichopus.*

GENERIC CHARACTERS

Rather small, yellowish to whitish aphids of a fragile, translucent appearance. Apterae without any sclerotic pigmentation of body or limbs, but with the head ornamented in 2 out of 3 British species with distinct nodular papillae, and the general body cuticle strongly and irregularly rugose. Frons very shallowly or hardly at all concave. Hairs on head and upper side of body in apterae conspicuously capitate, arranged in regular transverse (segmental) and longitudinal (spinal, pleural, pleuto-marginal and marginal) series. Siphunculi thin, cylindrical, rather short to elongate, rather rugose with a very small apical flange, entirely pale. Cauda rather small, elongate triangular, bluntish, with 5 to 7 hairs. Antennae without rhinaria in apterae. Alatae with a dark median abdominal patch from (2) 3–5 (6), and marginal sclerites on 2–4 inclusive. Capitate hairs less conspicuous in alatae. Rhinaria in alatae present on III only or on III and IV. First joints of tarsi in both forms with 5 hairs.

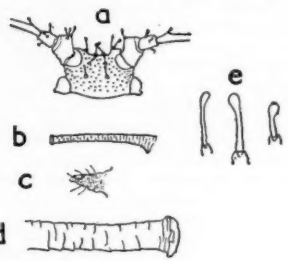


Fig. 12. *Pentatrichopus fragaefolii* (Ckll.), apt. v. ♀

a. Head. b. Siphunculus. c. Cauda. d. Apex of siphunculus, further enlarged. e. Types of frontal and basal antennal hairs, further enlarged.

ECONOMY

All the species are holocyclic on Rosaceae. The only important species is *P. fragaefolii*, which is a vector of strawberry virus diseases, and is probably more often than not anholocyclic in Britain. It lives under the leaves, particularly the young and senescent ones. Confusion is highly unlikely with any other genus. No other genus with marked capitate hairs lives on Rosaceae in this country and should any doubt arise, the 5-haired first tarsal joints can be used as a diagnostic character.

LITERATURE : THOMAS, I. and JACOB, F. H. (1941). *Proc. R. ent. Soc. Lond.* B, **10**, 107–23.

RHOPALOSIPHONINUS Baker

Theobald (**1**, 209) described six species in *Rhopalosiphoninus.* Of these, *ligustri* (Kalt.) belongs to a distinct genus, and the rest, with the exception of *R. calthae* (Koch), appear to be synonyms of *R. staphyleae* (Koch). *R. latysiphon* of Theobald is not the same as *R. latysiphon* (Davidson) which has, however, subsequently been found quite frequently in this country. *R. latysiphon* (Davidson) is the genotype set by Baker (1920).

GENERIC CHARACTERS

Medium-sized to large aphids, with body rather plump and convex dorsally, varying in colour from dirty yellowish or greenish to dark green, dark brown or blackish. Head with frons strongly concave, without a marked median

prominence, or at most with a slight median convexity. Head sometimes strongly spinulose, or in other cases with only a very few spinules on the anteroventral surface of the lateral frontal prominences. Antennae long and thin, processus terminalis from about 4 to 5½ times as long as the basal part of VI ; secondary rhinaria in apterae either absent, or present on III only ; in alatae either on III only, III–IV or, sometimes, on III–V inclusive. Abdominal dorsum in viviparae at least partly sclerotic, usually dark pigmented, frequently with a marked hexagonal reticulation. Spiracles small, not widely open. Siphunculi with basal half or third narrow and often transversely wrinkled, and then abruptly and strongly swollen, becoming constricted again to the strongly flanged apex. There are usually several rows of rather transverse reticulations near the apex. Cauda short, bluntly triangular, less than half as long as siphunculi, with few hairs arranged more or less in pairs. Wing veins in alatae may be rather brownish-bordered.

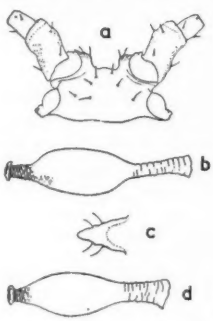


Fig. 13. *Rhopalosiphoninus* Baker, apt. v. ♀
a, b and c. Head, siphunculus and cauda of *R. latysiphon* (Davidson). d. Siphunculus of *R. staphyleae* (Koch).

ECONOMY

Biologically, the species of *Rhopalosiphoninus* are rather diverse, living on *Caltha*, *Ribes*, bulbs, root vegetables, *Vicia*, *Urtica*, *Vinca* and a wide variety of other plants. The only species of importance in Britain are *R. latysiphon* (Davidson) and *R. staphyleae* (Koch). The former may on occasions be a serious pest on bulbs under glasshouse conditions, while the latter, which lives more or less subterraneously on a wide variety of hosts, frequently breeds in enormous numbers on clamped mangolds. The two species are distinguished as follows : in *R. staphyleae* the head and first two antennal joints are strongly spinulose all over ; the antennal hairs are very short and inconspicuous ; the scabrous roughening of the antennal joints is very marked and there are frequently one or two to several rhinaria on III in apterae ; and the pigmentation of the abdominal dorsum is confined to the central area. In *R. latysiphon*, the head and antennae are smooth except for a few inconspicuous spinules ventrally and at the apices of the frontal prominences ; the antennal hairs are longer and more conspicuous (about two-thirds the basal diameter of III) ; rhinaria are absent in the apterae ; and the abdominal dorsum is more or less entirely uniformly sclerotic and dark pigmented. The apical part of the siphunculi in *R. latysiphon* is sub-cylindrical for an appreciable distance between the swollen part and the apical flange, and is much more strongly and noticeably reticulate than the same portion in *R. staphyleae*, where the swollen part narrows more gradually to the flange.

LITERATURE : An up-to-date account of *Rhopalosiphoninus* will shortly be published in the fifth part of Hille Ris Lambers' *Contributions to a Monograph of the Aphididae of Europe.*

RHOPALOSIPHUM Koch

Theobald (**2,** 57) places six species in *Rhopalosiphum*. Of these, *R. nymphaeae* (L.) and *R. prunifoliae* (Fitch) are the only true *Rhopalosiphum* species. His *R. eriophori* (Walker) is a *Ceruraphis*, *R. foeniculi* (Pass.) a *Hyadaphis*, *R. alboapicalis* Theob. a *Cryptomyzus*, and *R. rumicis* Theob. a *Cavariella*. His *R. prunifoliae* is apparently a mixture of *R. padi* (L.) and *R. insertum* (Walker).

At the same time he places *R. padi* (L.) in *Aphis* as *A. avenae* F., and proposes the name *A. crataegella n.n.* for a species on hawthorn which he takes to be *A. crataegi* Buckton nec Kalt., and which is in fact the same as *R. insertum* (Walker).

GENERIC CHARACTERS

Small to medium-sized aphids, rather variable in colour, sometimes very mealy but more usually not so. Frontal outline gently sinuate, with lateral prominences a little developed, distinctly higher than the median convexity. Antennae shorter than the body, without rhinaria in apterae ; in alatae with rhinaria on III, III–IV or III–V. Forms with 5-jointed antennae occur in the summer and autumn generations of *R. insertum* (Walker), the former in particular are almost entirely of this kind. Body cuticle membranous, without spinal pigmentation on the abdomen, except on the last three segments ; in apterae there is a more or less marked polygonal reticulation composed of small spinules, each polygon having also one or two spinules placed centrally within it. Very small finger-shaped marginal tubercles are constantly present on abdominal segments 1 and 7, those on the latter segment being displaced dorsally to lie closer to the mid-line than the corresponding tubercles in *Aphis* L. Spring forms may also have marginal tubercles on other intervening abdominal segments. Siphunculi short to fairly long—if longish, then with a slight but distinct swelling towards the apex ; almost smooth or slightly imbricate, with a distinct to very marked flange at apex. Cauda small, narrow, with about 4 to 7 hairs more or less in pairs. Apical joint of rostrum normal, rather short. Forewings of alatae with second fork of media very short (i.e., near the termen) or absent in some examples.

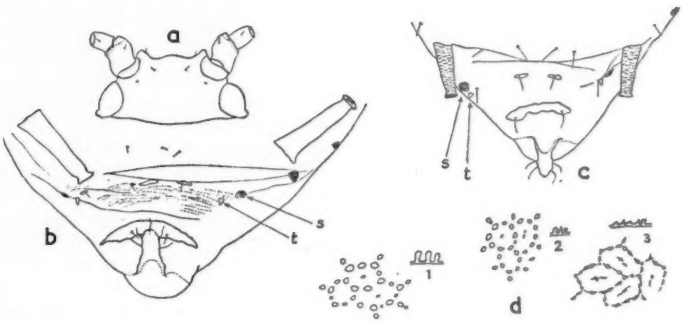


Fig. 14. *Rhopalosiphum* Koch, apt. v. ♀

a and b. Head and end of abdomen of *R. padi* (L.) showing relative position of (s) spiracle and (t) tubercle on VII. c. End of abdomen of *R. maidis* (Fitch). d. Abdominal sculpturing, and profile of spinules of 1. *R. nymphaeae* (L.). 2. *R. maidis* (Fitch). 3. *R. padi* (L.).

ECONOMY

Rhopalosiphum is typically heteroecious, migrating from Rosaceae to Gramineae or aquatic plants. *R. maidis* (Fitch), however, is apparently anholocyclic on Gramineae. All the four British species, *R. nymphaeae*, *R. padi*, *R. insertum* and *R. maidis*, are potentially important as pests of plums (*R. nymphaeae*), grassland and cereals (*R. padi*, *R. insertum* and *R. maidis*) or ornamental water plants (*R. nymphaeae*) ; while *R. insertum* may be at least a minor nuisance on apples and pears. The following short diagnoses of the species should enable them to be easily identified :

1 Primary host *Prunus padus*, the leaves of which are rolled longitudinally and become much fouled with honeydew. Apterae on *Prunus* very mealy. Alatae (spring migrants) with fairly long slender siphunculi only very slightly swollen towards apex. Apterae (exules) on grasses and reeds brownish to brownish-green, with a reddish suffusion at the base of each siphunculus, and antennae 6-jointed. Body not elongated on Gramineae. Siphunculi with moderately flared apical flange, fairly slender . . . *R. padi* (L.).

2 Primary hosts various Pomoidea, including apple, pear and hawthorn, whose leaves are lightly curled and slightly yellowed. Fundatrices not mealy, apple-green, second generation almost all alate emigrants. Summer generations with 5-jointed antennae, alate gynoparae also partly so. Always without reddish suffusion around siphunculi. Antennal joints of summer and autumn forms short and thick. Siphunculi rather short, stoutish, rather markedly dilated on apical half, and strongly flared at apex in summer and autumn specimens. Summer generations live on basal parts of oats and other Gramineae. Body not elongate . . . *R. insertum* (Walker).

3 Primary hosts *Prunus* spp., including peach and plum. Secondary hosts numerous species of aquatic plants. Siphunculi longer than in any of the other species, distinctly swollen on apical half, constricted again before the rather wide flange. Cuticular sculpturing very conspicuous in cleared specimens, the spinules composing it being rather regular and rounded, like small beads (in *R. padi* they are sharp and irregular). Colour very variable. Summer alatae with only 0–3 rhinaria on ant. IV, most often with none . . . *R. nymphaeae* (L.).

4 Primary host none. Anholocyclic on Gramineae, especially maize, barley, *Setaria*. Body markedly elongate, about twice as long as broad in apterae. Cuticular reticulation pale, rather as in *R. nymphaeae*, with fairly regular bead-like spinules. Siphunculi shorter than in the other species of the genus, more imbricate and with only a small flange and no distinct swelling. Colour pale green, with a dark purplish suffusion round the bases of the siphunculi . . . *R. maidis* (Fitch).

LITERATURE : Rogerson (*Bull. ent. Res.* 1947, **38**, 157–76) gives a valuable comparison of *R. padi* with *R. insertum* (under the name *R. crataegellum* Theob.). Börner (1932) gives a rather outmoded survey of the genus, which nevertheless contains some useful information.

SAPPAPHIS Matsumura

The synonymy of *Sappaphis* is complicated. The genus more or less corresponds to Theobald's (**2**, 220) group 2 of *Anuraphis* Del. G., and includes those species placed by Börner (1932) in *Yezabura* Mats., with the exception of *Y. eriophori*, *Y. marchali*, *Y. bakeri* and *Y. crataegifolii*. Other synonyms are *Dentatus* Van der Goot and *Dysaphis* Börner.

GENERIC CHARACTERS

Sappaphis belongs to the group of genera forming the tribe Anuraphidini, which typically have a short rounded, triangular or pentagonal cauda. In *Sappaphis* the cauda is always more or less angled apically, and only exceptionally has more than 7 hairs. Small to medium-sized, plump aphids, the apterae usually mottled greyish-green or pinkish-brown, with a rusty suffusion at the base of the siphunculi ; occasionally leaden grey ; usually with more or less conspicuous wax powdering, at least ventrally. Frons slightly sinuate, lateral prominences about as high as, or a little higher than, median convexity. Antennae short to moderate in length, 6-jointed except in fundatrices and oviparae, where they may be 5- or 6-jointed. Rhinaria in apterae typically absent, but alatiforms with rhinaria on III–IV are frequent in summer in most species. In alatae, rhinaria occur on III–IV or III–V, scattered over the whole of one side of the joints. Spinal tubercles occur almost always on the head and abdominal segment 8 or 7–8, and may be present on other segments also. Marginal tubercles on pronotum

and segments 1–5 as a rule, also frequently on mesonotum and metanotum and segments 7 or 6–7. Dorsal sclerotic pattern in apterae usually confined to spinal bars on segments 5–8 or 6–8, small more or less paired spinal scleroites on the anterior abdominal segments and more or less broken transverse bars on pronotum and sometimes on mesonotum and metanotum. The whole abdominal dorsum is never solidly sclerotic (cf. *Brachycaudus*). In alatiforms an approach may be made to the alate type of pattern, which consists essentially of transverse bars across all the abdominal segments, those on segments 3–6 being more or less fused into a solid dark plate, and those on segments 1–2 being usually broken or even absent. The marginal tubercles in alatae lie on segmental marginal sclerites from segments 2–5 inclusive. Spiracles normal, somewhat oval or reniform (cf. *Brachycaudus*). Siphunculi rather short to moderate, cylindrical or slightly tapering, more or less imbricate, with a small to moderate but well-marked apical flange, sometimes with a fairly clear preapical circumcision. Rostrum normal. Alatae with wing venation normal, media of forewing twice branched.

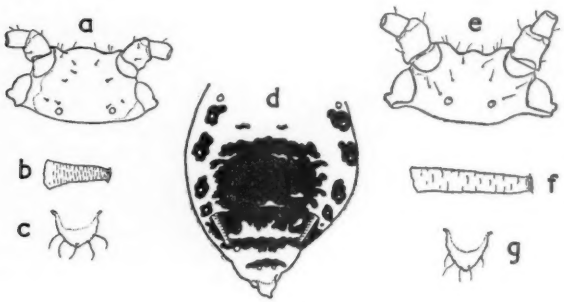


Fig. 15. *Sappaphis* Mats.

a, b and c. Head, siphunculus and cauda of *S. crataegi* (Kalt.). apt. v. ♀.

d. Abdomenal pattern of *S. crataegi*. Al. v. ♀.

e, f and g. Head, siphunculus and cauda of *S. mali* (Ferr.), apt. v. ♀ (apple).

ECONOMY

The species of *Sappaphis* typically migrate from apple, pear, hawthorn or *Sorbus* spp. to various secondary hosts among the Umbelliferae, *Rumex*, *Plantago*, Monocotyledons, etc., but never to Gramineae or Cyperaceae. Of the twenty or so British species, only five are of any importance : *S. mali* Ferr. (syn. *S. plantaginea*, *S. malifoliae*, *S. roseus* auct.), *S. pyri* Fonsc., *S. devecta* Walker, *S. crataegi* Kalt. and *S. tulipae* Fonsc. The first and third are pests of apple, where they crumple the leaves to form respectively yellow and crimson twisted galls ; *S. pyri* causes rather similar damage on pear ; *S. crataegi* infests the root collars of its secondary host, carrot, to which it migrates from hawthorn ; and *S. tulipae* attacks bulbs and other Monocotyledons such as *Iris* and *Crocus*, to which it may do much damage in storage. In addition, *S. inculta* (Wlk.), migrating from hawthorn to celery and parsley, may occasionally be a pest of celery ; while *S. radicicola* (Mordv.), living apparently anholocyclically (in Britain, though not in Eastern Europe) on docks, may be a potential though casual vector of two Brassica virus diseases. Morphologically, the genus is a very difficult one, and any specimens whose host plant is not sufficient to identify the species should be submitted for a specialist opinion.

LITERATURE : The writer hopes soon to publish an account of this genus.

SITOBION Mordvilko

The two principal names under which Theobald described the species of *Sitobion* were *Macrosiphum granarium* (Kirby) and *M. rubiellum* Theob. ; but he also described vagrants several times under other names such as *M. alii*, *Myzus molluginellus*, *Aphis dallmani* and *Myzus laricellus*. *M. granarium* and *M. alii* are synonyms of *Sitobion avenae* (F.), the remainder of *S. fragariae* (Walker). Hille Ris Lambers (**4**, 72) puts *Sitobion* as a subgenus of *Macrosiphum*. It has been considered desirable to keep them separate in the present account.

GENERIC CHARACTERS

Medium-sized green to dull brownish-green or reddish-brown aphids, with blackish antennae and siphunculi. Frons rather w-shaped, with the lateral prominences similar to *Metopolophium* and a small median prominence. Head smooth. Rhinaria in apterae confined to a small group of 1–4 near the base of III, or occasionally absent ; in alatae there are 5–25 arranged in a single row along most of the length of III. The dorsal sclerotic pattern is typically intersegmental in origin, like that of *Nasonovia*, and consists of intersegmental muscle sclerites surrounded by areas of dark pigmentation (more conspicuous in the grass forms than in the *Rubus* forms) and a greater or less degree of darkish suffusion of the rather sclerotic tergum in the apterae ; apterae of *S. avenae* frequently have a more or less completely brownish sclerotic tergum. Siphunculi moderate to rather long, blackish sclerotic, a little imbricate, with the apical one-tenth to one-third reticulated and a small but distinct flange. Cauda elongate, finger-shaped or rather acute at apex (mainly in alatae), pale, often constricted in the middle ; from half to nine-tenths as long as siphunculi ; with 7–12 hairs. The combination of reticulated siphunculi with an intersegmental sclerotic pattern is characteristic of *Sitobion*. Rostrum with apical joint blunt and rather short, as is typical for many genera living on the aerial portions of Gramineae.

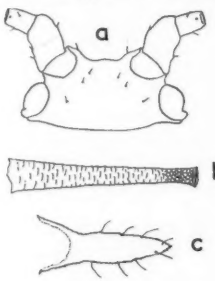


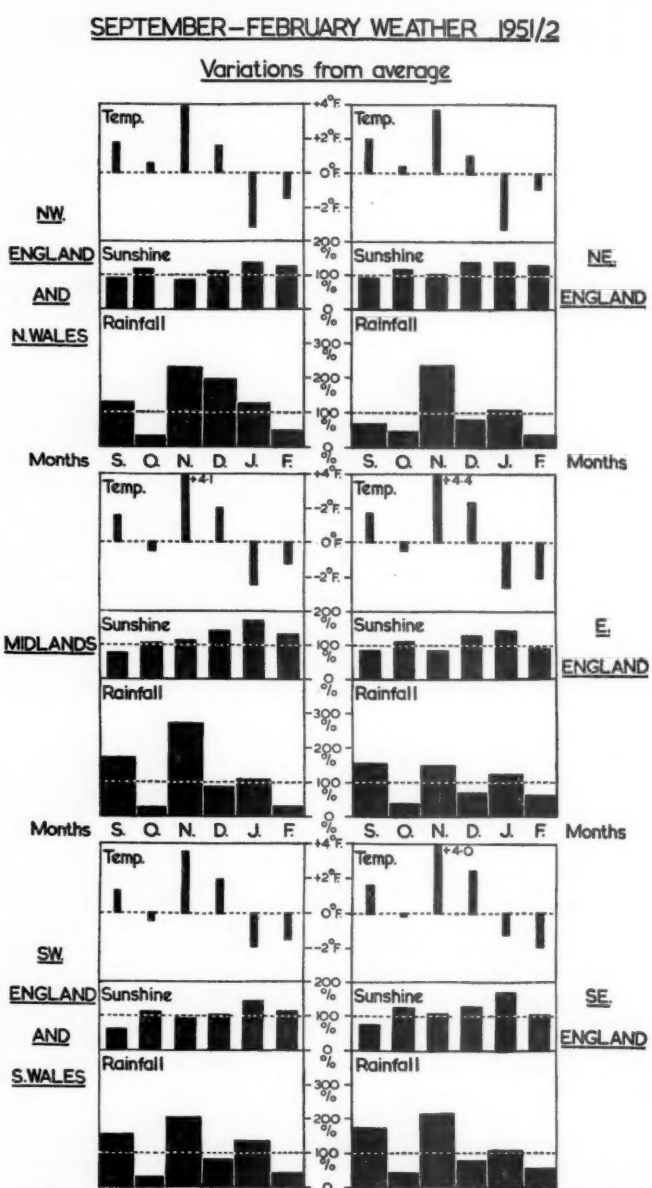
Fig. 16. *Sitobion avenae* (F.). apt. v. ♀. a. Head. b. Siphunculus. c. Cauda.

ECONOMY

Biologically, *Sitobion* is closely parallel to *Metopolophium*, as has been observed by Hille Ris Lambers (**7**, 276). *S. fragariae* (Walker) is heteroecious, migrating from *Rubus* spp. to grasses, and occurs occasionally on other Rosaceae and on species of *Carex*. *S. avenae* (F.) lives throughout the year on grasses, and also attacks various other Monocotyledons occasionally. Both species can be a nuisance on cereals and on grass grown for seed. Specimens from grasses can be separated by the ratio of the siphuncular to caudal length ; this is about 2 : 1 in *S. fragariae*, but not more than $1\frac{1}{2}$: 1 in *S. avenae*. There is a third species, *S. luteum* (Buckton) on orchids under glass, but this is too uncommon to require treatment here. Theobald places this species in *Macrosiphoniella*.

LITERATURE : Hille Ris Lambers (*Temminckia*, **7**, 108).

This concludes the present series of short descriptions of 16 genera of aphids of economic importance in Britain. A key to these, and related genera, will follow in the next issue of this JOURNAL.


SEPTEMBER–FEBRUARY WEATHER 1951/2
Variations from average
NW. ENGLAND AND N.WALES
NE. ENGLAND
MIDLANDS
E. ENGLAND
SW. ENGLAND AND S.WALES
SE. ENGLAND
Temp.
Sunshine
Rainfall
+4·1
+4·4
+4·0
+4°F.
+2°F.
0°F.
-2°F.
200%
100%
0%
300%
Months
S. O. N. D. J. F.

THE WEATHER OF ENGLAND AND WALES*

AUTUMN AND WINTER, 1951-52

After a poor and short-lived summer, autumnal weather in 1951 was prolonged and mild. The opening weeks of September provided high day and night temperatures, reaching over 75° F. by day at a number of places on the 4th ; humidities also were very high, with the result that fogs and thunderstorms were common. Fairer conditions prevailed during the latter half of the month, but scattered thunderstorms occurred in most areas. October was unusually dry ; in a month which normally has a high rainfall, the totals were generally between a quarter and a half of average ; sunshine amounts were fairly high, especially early in the month ; fogs were frequent and temperatures about normal. November was exceptionally mild and very wet ; except in East England, over twice the average amount of rain fell, and mean temperatures were 4° F. or more above normal values. The mild weather continued in December, but to a less extent ; the rains continued in the north-west but the east and south had much drier weather.

Winter conditions began over most of the country with the onset of northerly winds about the second week in January, and from then until the middle of February, temperatures were well below average. There were frequent falls of snow, but amounts were small in most lowland and southern areas, although falls were sometimes heavy in hilly districts. Sunshine totals during the cold spell were conspicuously high, and in several places, such as Oxford, Kew, Birmingham, Southport and Ross-on-Wye, it was the sunniest January on record. Milder weather returned during the latter half of February, but the month as a whole was cold and dry, the rainfall (including snow) being about half average.

The weather for each of the six months September to February (inclusive) is represented graphically on page 100. Figures for six districts of England and Wales are shown in terms of deviation from average for air temperature, sunshine and rainfall. Outstanding features are the wet November, the dry October and February, the warm November, the cold January, and the excess winter sunshine.

NEW OR UNCOMMON PLANT DISEASES IN ENGLAND AND WALES

Mosaic on Cocksfoot. A distinct leaf mottle was observed on cocksfoot on one of the plots in a grass variety trial at Malton, Yorks, in 1950. Specimens were sent to Dr. Kenneth Smith at Cambridge, who reported in June 1951 that he had transmitted infection both mechanically and by aphids to cocksfoot seedlings. The symptoms were observed again on the original plot in 1951, but there was little evidence that any spread had occurred. This appears to be the first record of a virus disease on a member of the Gramineae (except *Zea mays*) in Europe outside Russia. I. F. STOREY

* These notes, and the diagram on page 100, are provided by the Agricultural Branch of the Meteorological Office, and are published by permission of the Director.

Lucerne Anthracnose. Wilting, and breaking-off of plants at the stem base where black lesions were present, was noted in a plot of lucerne at Wye, Kent, in 1950. Affected plants were scattered throughout the plots but were most abundant in two circular patches corresponding to slight depressions in the ground. On August 12, plants in these areas were almost defoliated, but after the crop was cut, on August 13, subsequent growth remained healthy. Acervuli of *Colletotrichum* sp. with spores measuring 15 × 5μ were present on most of the dark lesions. This was the first record of a *Colletotrichum* on lucerne in this country. In America, two species *C. trifolii* Bain & Ess. and *C. destructiva* O'Gara, have been recorded on *Medicago sativa*, but they appear to be very similar and the one recorded here is probably best referred to *C. trifolii*.

H. H. GLASSCOCK

Powdery Scab on Tomato Roots. Galls on tomato roots, somewhat resembling Root Knot eelworm, were found in clearing a crop in a house at March, Isle of Ely, in October 1950. The plants had shown no adverse effects during the growing season. After careful search, spore balls resembling those of *Spongospora subterranea* (Wallr.) Lagerh. were found in affected root tissue. Seed potatoes were regularly chitted in the same house. Similar symptoms were also found on tomato roots at Ardleigh, Essex, in October 1950, where also there was no apparent adverse effect on the plants during the growing season. McKay (*Tomato Diseases*, Dublin, 1949, 42–3) gives an illustrated account of this disease in Eire.

W. A. R. DILLON WESTON, R. ERIC TAYLOR, AND F. JOAN MOORE

Trichothecium Fruit Rot of Tomatoes. A stem-end rot associated with a profuse development of *Trichothecium roseum* Fr. caused severe fruit drop in a poorly ventilated cold glasshouse at Baldock, Herts., in October 1951. Leaf Mould (*Cladosporium fulvum*) had been severe and had attacked the calyces remaining on the fruits. *Trichothecium* was isolated from affected fruits and was proved by J. A. Tomlinson at Harpenden to be pathogenic to wounded ripe fruits. Deems (*Phytopathology*, 1951, **41**, 633–40) has recently recorded the same disease in America.

R. ERIC TAYLOR

Leaf Spot on Polyanthus. Circular dark-brown lesions, 5-10 mm. diameter, papery in texture and surrounded by a yellow halo, were observed on miscellaneous polyanthus plants in park flower beds at Bristol, Som., in October 1951. Numerous pycnidia were present on the lesions, but were mostly empty when the material was collected. In culture, pycnidia were produced in abundance, with spores 3–6 × 1–3μ. These measurements agree with those given for *Phyllosticta primulicola* Desm. which, according to Grove (*British Stem and Leaf Fungi*, 1935, **1**, 34), is very common on primroses and has been recorded by Dennis and Foister (*Trans. Brit. mycol. Soc.*, 1942, **25**, 295) on *Primula* sp. in Scotland.

A. G. ROBERTSON

Spotted Wilt on Hoya. In October 1951 W. Buddin sent me some leaves of *Hoya carnosa* showing chlorotic concentric ring patterns from Hounslow, Middlesex. The presence of tomato spotted wilt virus was confirmed by inoculation to *Nicotiana glutinosa*. This is a new host record.

I. W. PRENTICE

(54037) Wt. 42/43 K.8 9/52 Hw.